TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
A Teledyne Technologies Company

Operation Manual

MODEL 300E FAMILY

CARBON MONOXIDE ANALYZERS

(Includes M300E, M300EM)

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04288D DCN 5752
24 June 2011

SAFETY MESSAGES

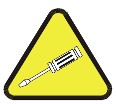
Warning and cautionary messages are provided for the purpose of avoiding risk of personal injury or instrument damage. These important safety messages and associated safety alert symbols are found throughout this manual; the safety symbols are also located inside the instrument(s). It is imperative that you pay close attention to these messages, the descriptions of which are as follows:

WARNING: Electrical Shock Hazard

HAZARD: Strong oxidizer

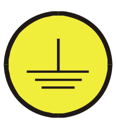
GENERAL WARNING/CAUTION: Read the accompanying message for specific information.

CAUTION: Hot Surface Warning



Technician Symbol: All operations marked with this symbol are to be performed by qualified maintenance personnel only.

DO NOT TOUCH: Touching some parts of the instrument without protection or proper tools could result in damage to the part(s) and/or the instrument.



Electrical Ground: This symbol inside the instrument marks the central safety grounding point for the instrument.

CAUTION – GENERAL SAFETY HAZARD

This instrument should only be used for the purpose and in the manner described in this manual. If you use this instrument in a manner other than that for which it was intended, unpredictable behavior could ensue with possible hazardous consequences.

Never use any gas analyzer to sample combustible gas(es).

Note

Technical Assistance regarding the use and maintenance of this or any other Teledyne API product can be obtained by contacting Teledyne API's Customer Service Department:

Telephone: 800-324-5190

Email: api-customerservice@teledyne.com

or by accessing various service options on our website at http://www.teledyne-api.com/.

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WARRANTY

WARRANTY POLICY (02024D)

Prior to shipment, T-API equipment is thoroughly inspected and tested. Should equipment failure occur, T-API assures its customers that prompt service and support will be available.

COVERAGE

After the warranty period and throughout the equipment lifetime, T-API stands ready to provide on-site or in-plant service at reasonable rates similar to those of other manufacturers in the industry. All maintenance and the first level of field troubleshooting are to be performed by the customer.

NON-API MANUFACTURED EQUIPMENT

Equipment provided but not manufactured by T-API is warranted and will be repaired to the extent and according to the current terms and conditions of the respective equipment manufacturer's warranty.

GENERAL

During the warranty period, T-API warrants each Product manufactured by T-API to be free from defects in material and workmanship under normal use and service. Expendable parts are excluded.

If a Product fails to conform to its specifications within the warranty period, API shall correct such defect by, in API's discretion, repairing or replacing such defective Product or refunding the purchase price of such Product.

The warranties set forth in this section shall be of no force or effect with respect to any Product: (i) that has been altered or subjected to misuse, negligence or accident, or (ii) that has been used in any manner other than in accordance with the instruction provided by T-API, or (iii) not properly maintained.

THE WARRANTIES SET FORTH IN THIS SECTION AND THE REMEDIES THEREFORE ARE EXCLUSIVE AND IN LIEU OF ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE OR OTHER WARRANTY OF QUALITY, WHETHER EXPRESSED OR IMPLIED. THE REMEDIES SET FORTH IN THIS SECTION ARE THE EXCLUSIVE REMEDIES FOR BREACH OF ANY WARRANTY CONTAINED HEREIN. API SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR RELATED TO THIS AGREEMENT OF T-API'S PERFORMANCE HEREUNDER, WHETHER FOR BREACH OF WARRANTY OR OTHERWISE

TERMS AND CONDITIONS

All units or components returned to Teledyne API should be properly packed for handling and returned freight prepaid to the nearest designated Service Center. After the repair, the equipment will be returned, freight prepaid.

CAUTION – Avoid Warranty Invalidation

Failure to comply with proper anti-Electro-Static Discharge (ESD) handling and packing instructions and Return Merchandise Authorization (RMA) procedures when returning parts for repair or calibration may void your warranty. For anti-ESD handling and packing instructions please refer to "Packing Components for Return to Teledyne API's Customer Service" in the *Primer on Electro-Static Discharge* section of this manual, and for RMA procedures please refer to our Website at http://www.teledyne-api.com under Customer Support > Return Authorization.

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ABOUT THIS MANUAL

This manual is comprised of multiple documents, in PDF format, as listed below.

Part No.	Rev	Name/Description
04288	D	M300E/EM Manual
04906	H	Menu Tree and Software Documentation, L.8 (as Appendix A of this manual)
05362	J	Spare Parts List, M300E (in Appendix B of this manual)
05424	H	Spare Parts List, M300EM (in Appendix B of this manual)
04302	Q	Recommended Spares Stocking Levels, M300E (in Appendix B of this manual)
04834	G	Recommended Spares Stocking Levels, M300EM (in Appendix B of this manual)
009600400	C	Expendables Kit, M300E/M300EM (in Appendix B of this manual)
040360100	A	Spares Kit, M300E/M300EM (1 unit) (in Appendix B of this manual)
04305	G	Warranty/Repair Request Questionnaire (as Appendix C of this manual)
03297	K	PCA, 03296, IR Photodetector Preamp and Sync Demodulator (In Appendix D of this manual)
03632	A	PCA, 03631, 0-20mA driver (in Appendix D of this manual)
03976	B	PCA, 03975, Keyboard & Display Driver (in Appendix D of this manual)
04354	D	Schematic, PCA 04003, Press/Flow (in Appendix D of this manual)
05703	A	PCA, 05702, Motherboard, E-Series Gen 4 (in Appendix D of this manual)
04089	A	PCA, 04088, Opto Pickup Interface (in Appendix D of this manual)
04136	B	PCA, 04135 Rev A, M300E Relay (in Appendix D of this manual)
04216	E	Interconnect Drawing - M300E SNs >=100 (in Appendix D of this manual)
04217	F	Interconnect List - M300E SNs >=100 (in Appendix D of this manual)
04259	A	PCA, 04258, Keyboard & Display Driver (in Appendix D of this manual)
04468	B	PCA, 04467, Analog Output Isolator, / Series Resistor (in Appendix D of this manual)

NOTE

We recommend that this manual be read in its entirety before making any attempt made to operate the instrument.

REVISION HISTORY

2010 June 08				
Document	**PN**	**Rev**	**DCN**	**Change Summary**
M300E/M300EM Manual	04288	D	5752	• Combined "Title" and "Text" portions of manual into one document for single part number. • Created front matter content to include Safety Messages, Warranty, About This Manual (incl. manual BOM), and Revision History sections. • Added cautionary messages to avoid invalidating warranty. • Corrected bp filter descrip. from 4.3 µm to 4.7 µm • Updated setup instructions for RS-232 multidrop and RS-485 communications (Sections 8.2, 8.3) • Updated CPU description and replacement procedures to fit the E-series CPU. • Updated instructions/added illustration for current (I) conversion configuration. • Clarified description of the GFC operation (Section 1.2). • Added Pressure Flow schematic to Appendix D. • Added Elec Test calibration (Section 13.5.6.2). • Clarified password behavior (Section 6.5.3). • Added MODBUS Quick Setup instr. (Section 8.5).

2011, June 08, M300E/M300EM Manual, PN04288 Rev D (initial capture)

For the purpose of capturing this manual's construct at Rev D when the addition of this new *Revision History* section was initiated, the following list shows the current documents comprising this manual. Any future changes to this manual will be recorded in this *Revision History* section; the preceding *About This Manual* section will be updated as well.

Part No.	Rev	Name/Description
04288	D	M300E/EM Manual
04906	H	Menu Tree and Software Documentation, L.8 (as Appendix A of this manual)
05362	J	Spare Parts List, M300E (in Appendix B of this manual)
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PART I
–
GENERAL INFORMATION

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1. INTRODUCTION

1.1. M300E FAMILY OVERVIEW

The family includes the M300E and the M300EM Gas Filter Correlation Carbon Monoxide Analyzer. The M300E family of analyzers is a microprocessor-controlled analyzer that determines the concentration of carbon monoxide (CO) in a sample gas drawn through the instrument. It uses a method based on the Beer-Lambert law, an empirical relationship that relates the absorption of light to the properties of the material through which the light is traveling over a defined distance. In this case the light is infrared radiation (IR) traveling through a sample chamber filled with gas bearing a varying concentration of CO.

The M300E/EM uses Gas Filter Correlation (GFC) to overcome the interfering effects of various other gases (such as water vapor) that also absorb IR. The analyzer passes the IR beam through a spinning wheel made up of two separate chambers, one containing a high concentration of CO, known as the reference, and the other containing a neutral gas known as the measure. The concentration of CO in the sample chamber is computed by taking the ratio of the instantaneous measure and reference values and then compensating the ratio for sample temperature and pressure.

The M300E/EM Analyzer's multi-tasking software gives the ability to track and report a large number of operational parameters in real time. These readings are compared to diagnostic limits kept in the analyzers memory and should any fall outside of those limits the analyzer issues automatic warnings.

Built-in data acquisition capability, using the analyzer's internal memory, allows the logging of multiple parameters including averaged or instantaneous concentration values, calibration data, and operating parameters such as pressure and flow rate. Stored data are easily retrieved through the serial port or optional Ethernet port via our APICOM software or from the front panel, allowing operators to perform predictive diagnostics and enhanced data analysis by tracking parameter trends. Multiple averaging periods of one minute to 365 days are available for over a period of one year.

Some of the common features of your M300E family of analyzers are:

- Microprocessor controlled for versatility
- Multi-tasking software allows viewing of test variables during operation
- Continuous self checking with alarms
- Bi-directional RS-232 for remote operation
- Digital status outputs indicate instrument operating condition
- Adaptive signal filtering optimizes response time
- Gas Filter Correlation Wheel for CO specific measurement
- GFC Wheel guaranteed against leaks for 5 years
- Temperature & Pressure compensation
- Internal data logging with 1 min to 365 day multiple average
- Remote operation when used with Teledyne API's APICOM software

M300E FEATURES:

- Ranges, 0-1 ppm to 0-1000 ppm, user selectable
- 14-meter path length for sensitivity

M300EM FEATURES:

- Ranges, 0-1 ppm; Max: 0-5000 ppm, user selectable
- 2.5 meter path length for dynamic range

Several options can be purchased for the analyzer that allows the user to more easily supply and manipulate Zero Air and Span Gas. For more information of these options, see Section 5.6.

1.2. ADDITIONAL DOCUMENTATION

Additional documentation for the M300E/EM CO Analyzer is available from Teledyne API's website at http://www.teledyne-api.com/manuals/.

- APICOM software manual, P/N 03945.
- DAS Manual, P/N 02837.

1.2.1. USING THIS MANUAL

> **NOTE**
>
> **This manual explains the operation and use of both the M300E and the M300EM Gas Filter Correlation Carbon Monoxide Analyzer.**
>
> **For the most part these two instruments are nearly identical in their features and functions.**
>
> **The examples and illustrations shown in this manual represent the M300E. Where a significant difference does exist between the different models, each version is shown.**

> **NOTE**
>
> **Throughout this manual, words printed in capital, bold letters, such as SETUP or ENTR represent messages as they appear on the analyzer's display.**

This manual has the following structure:

TABLE OF CONTENTS:

Outlines the contents of the manual in the order the information are presented. This is a good overview of the topics covered in the manual. There is also a list of appendices, figures and tables.

PART I – GENERAL INFORMATION

INTRODUCTION
A brief description of the M300E/EM Analyzer architecture as well as a description of the layout of the manual and what information is located in its various sections.

SPECIFICATIONS AND WARRANTY
Lists the performance specifications of the analyzers . If applicable, a description of the conditions and configuration under which EPA equivalency was approved as well as the Teledyne API's warranty statement.

GETTING STARTED
This section provides instructions for setting up, installing and running your analyzer for the first time.

GLOSSARY
Answers to the most frequently asked questions about operating the analyzer and a glossary of acronyms and technical terms.

OPTIONAL HARDWARE & SOFTWARE
The section describes the optional equipment and their functions for your analyzer.

PART II – OPERATING INSTRUCTIONS

BASIC OPERATION OF THE M300E/EM ANALYZER
Step-by-Step instructions for using the display/keyboard to set up and operate the M300E/EM Analyzer.

ADVANCED FEATURES OF THE M300E/EM ANALYZER
Step-by-Step instructions for using the M300E/EM Analyzer's more advanced features such as the iDAS system, the **DIAG** and **VARS** menus and the and the **TEST** channel analog output.

REMOTE OPERATION OF THE M300E/EM Analyzer
Information and instructions for interacting with the M300E/EM Analyzer via its several remote interface options (e.g. via RS-232, Ethernet, its built in digital control inputs/outputs, etc.)

M300E/EM VALIDATION AND VERIFICATION
Methods and procedures for verifying the correct operation of your M300E/EM Analyzer as well as step by step instructions for calibrating it.

EPA PROTOCOL CALIBRATION
Specific information regarding calibration requirements for analyzers used in EPA monitoring.

PART III – TECHNICAL INFORMATION

THEORY OF OPERATION
An in-depth look at the various principals by which the analyzer operates as well as a description of how the various electronic, mechanical and pneumatic components of the analyzer work and interact with each other. A close reading of this section is invaluable for understanding the analyzer's operation.

MAINTENANCE SCHEDULE AND PROCEDURES
Description of preventative maintenance procedures that should be regularly performed on the analyzer to assure good operating condition.

GENERAL TROUBLESHOOTING & REPAIR OF THE M300E/EM ANALYZER
This section includes pointers and instructions for diagnosing problems with the analyzer in general and the Terminus as well as instructions on performing repairs of on the Terminus.

A PRIMER ON ELECTRO-STATIC DISCHARGE
This section describes how static electricity occurs; why it is a significant concern and; how to avoid it and avoid allowing ESD to affect the reliable and accurate operation of your analyzer.

APPENDICES

For easier access and better updating, some information has been separated out of the manual and placed in a series of appendices at the end of this manual. These include version-specific software menu trees, warning messages, definitions Modbus registers and serial I/O variables as well as spare part listings, repair questionnaires, interconnect drawing, detailed pneumatic and electronic schematics.

NOTE

The flowcharts in this manual contain typical representations of the analyzer's display during the various operations being described. These representations are not intended to be exact and may differ slightly from the actual display of the instrument.

2. SPECIFICATIONS AND APPROVALS

2.1. SPECIFICATIONS

Table 2-1: M 300E/300EM Basic Unit Specifications

Ranges	M300E: Min: 0-1 ppm; Max: 0-1000 ppm of Full Scale (User selectable) M300EM: Min: 0-5 ppm; Max: 0-5000 ppm of Full Scale (User selectable)
Measurement Units	M300E: ppb, ppm, µg/m^3, mg/m^3 (user selectable) M300EM: ppm, mg/m^3 (user selectable)
Zero Noise	M300E: < 0.02 ppm RMS[1];M300EM: ≤ 0.1 ppm RMS
Span Noise	M300E:<0.5% of rdg RMS over 5ppm[1, 3]; M300EM:>0.5% of rdg RMS over 20ppm
Lower Detectable Limit[1]	M300E: < 0.04 ppm; M300EM: 0.2 ppm
Zero Drift (24 hours)[2]	M300E: < 0.1 ppm; M300EM: <0.5 ppm
Zero Drift (7 days)[2]	M300E: < 0.2 ppm; M300EM: <1.0ppm
Span Drift (24 hour[2]s)	The greater of < 0.5% of reading or 0.1ppm (M300E), 0.5ppm(M300EM)
Span Drift (7 days)[2]	The greater of < 1% of reading or 0.5ppm (M300E), 1 ppm(M300EM)
Linearity	M300E: Better than 1% Full Scale[5]; M300EM: 0 - 3000 ppm: 1% full scale; 3000 - 5000 ppm: 2% full scale
Precision	M300E: The greater of 0.5% of reading or 0.2ppm; M300EM: The greater of 1.0% of reading or 1ppm
Lag Time[1]	10 sec[1]
Rise/Fall Time[1]	<60 sec to 95%[1]
Sample Flow Rate	800 cm^3/min. ±10% O_2 Sensor option adds 120 cm^3/min to total flow though when installed
Temperature Range	5 - 40°C operating, 10 - 40°C EPA Equivalency (M300E only)
Humidity Range	0-95% RH, Non-Condensing
Temp Coefficient	< 0.05 % per °C (minimum 50 ppb/°C)
Voltage Coefficient	< 0.05 % per V
Dimensions (HxWxD)	7" x 17" x 23.5" (178 mm x 432 mm x 597 mm)
Weight	50 lb (22.7 kg)
AC Power	100V 50/60 Hz (3.25A), 115 V 60 Hz (3.0A), 220 – 240 V 50/60 Hz (2.5A)
Environmental Conditions	Installation Category (Over voltage Category) II Pollution Degree 2
Analog Outputs	4 user configurable outputs
Analog Output Ranges	All Outputs: 0.1V, 1V, 5V or 10V Three outputs convertible to 4-20 mA isolated current loop. All Ranges with 5% under/over-range
Analog Output Resolution	1 part in 4096 of selected full-scale voltage
Status Outputs	8 Status outputs from opto-isolators
Control Inputs	6 Control Inputs, 2 defined, 4 spare
Serial I/O	One (1) RS-232/optional multidrop; One (1) RS-232/optional RS-485 (2 connecters in parallel) Baud Rate : 300 - 115200
Alarm outputs (optional)	2 opto-isolated alarm outputs and 2 dry contact alarm outputs
Certifications	USEPA: Reference Method Number EQOA-0992-087 CE: EN61010-1:90 + A1:92 + A2:95, EN61326 - Class A

[1] As defined by the USEPA [2] At constant temperature and pressure

2.2. EPA EQUIVALENCY DESIGNATION

Teledyne API's M300E Carbon Monoxide Analyzer is designated as Reference Method Number EQOA-0992-087 as defined in 40 CFR Part 53, when operated under the following conditions:

- Range: Any range from 10 ppm to 50 ppm.
- Ambient temperature range of 10 to 40°C.
- Line voltage range of 90 – 127 and 200 – 230 VAC, 50/60 Hz.
- Sample filter: Equipped with PTFE filter element in the internal filter assembly.
- Sample flow of 800 ± 80 cm^3/min at sea level.
- Internal sample pump.
- Software settings:

Dilution factor	1.0
AutoCal	ON or OFF
Dynamic Zero	ON or OFF
Dynamic Span	OFF
Dual range	ON or OFF
Auto range	ON or OFF
Temp/Pres compensation	ON

Under the designation, the analyzer may be operated with or without the following options:

- Rack mount with slides.
- Rack mount without slides, ears only.
- Zero/span valve options.
    - Option 50A – Sample/Cal valves, or;
    - Option 50B – Sample/Cal valves with span shutoff & flow control.
- Internal zero/span (IZS) option with either:
    - Option 51A – Sample/Cal valves, or;
    - Option 51C – Sample/Cal valves with span shutoff & flow control.
- Status outputs.
- Control inputs.
- RS-232 output.
- Ethernet output.
- 4-20mA, isolated output.

2.3. TUV DESIGNATION

On behalf of Teledyne Advanced Pollution Instrumentation TÜV Rheinland Immissionsschutz und Energiesysteme GmbH has performed the suitability test of the measuring system M300E for the component carbon monoxide.

The suitability test was carried out in compliance with the following guidelines and requirements:

- EN 14626 Ambient Air Quality – Standard method for the measurement of the concentration of carbon monoxide by nondispersive infrared spectroscopy, March 2005.

The measuring system M300E operates using the non-dispersive infrared spectroscopy.

The investigations have been carried out in the laboratory and during a field test, lasting three months. The tested measuring ranges are:

Component		Measuring Range		
Carbon Monoxide	CO	100	mg/m^3	EN 14626
NOTE: 0-100 ppm correlates to 0-100 µmol/mol or 0-116 mg/m^3 (at 293 K and 1013 mbar).				

The minimum requirements have been fulfilled in the suitability test.

Therefore the TÜV Immissionsschutz and Energiesysteme GmbH proposes the publication as a suitability-tested measuring system for continuous monitoring of carbon monoxide in the ambient air.

2.4. CE MARK COMPLIANCE

2.4.1. EMISSIONS COMPLIANCE

Teledyne API's M300E/EM Gas Filter Correlation CO Analyzer was tested and found to be fully compliant with:

EN61326 (1997 w/A1: 98) Class A, FCC Part 15 Subpart B section 15.107 Class A, ICES-003 Class A (ANSI C63.4 1992) & AS/NZS 3548 (w/A1 & A2; 97) Class A.

Tested on 11-29-2001 at CKC Laboratories, Inc., Report Number CE01-249.

2.4.2. SAFETY COMPLIANCE

Teledyne API's M300E/EM Gas Filter Correlation CO Analyzer was tested and found to be fully compliant with:

IEC 61010-1:90 + A1:92 + A2:95,

Tested on 02-06-2002 at NEMKO, Report Number 2002-012219.

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3. GETTING STARTED

3.1. M300E/EM ANALYZER LAYOUT

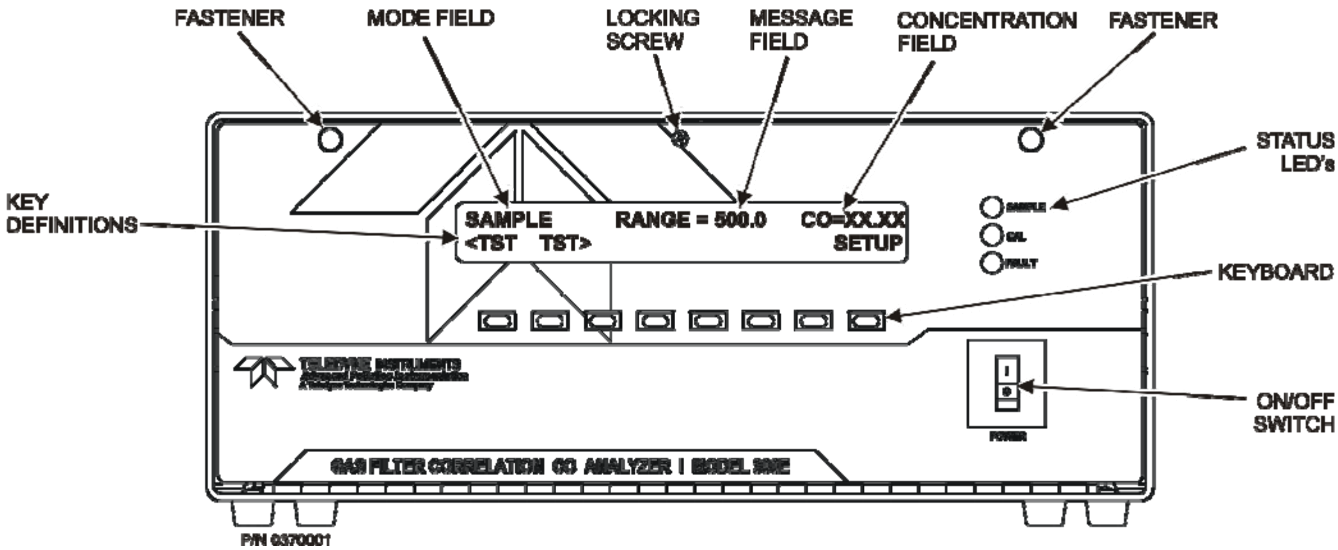


Figure 3-1: Front Panel Layout

Table 3-1: Front Panel Nomenclature

Name	Significance		
Mode Field	Displays the name of the analyzer's current operating mode.		
Message Field	Displays a variety of informational messages such as warning messages, operational data, test function values and response messages during interactive tasks.		
Concentration Field	Displays the actual concentration of the sample gas currently being measured by the analyzer in the currently selected units of measure.		
Keypad Definition Field	Displays dynamic, context sensitive definitions for the row of keys just below the display.		
STATUS LED's			
Name	Color	State	Definition
SAMPLE	Green	Off On Blinking	Unit is not operating in sample mode, iDAS is disabled. Sample Mode active; Front Panel Display being updated; iDAS data being stored. Unit is operating in sample mode, front panel display being updated, iDAS hold-off mode is ON, iDAS disabled
CAL	Yellow	Off On Blinking	Auto Cal disabled Auto Cal enabled Unit is in calibration mode
FAULT	Red	Off Blinking	No warnings exist Warnings exist

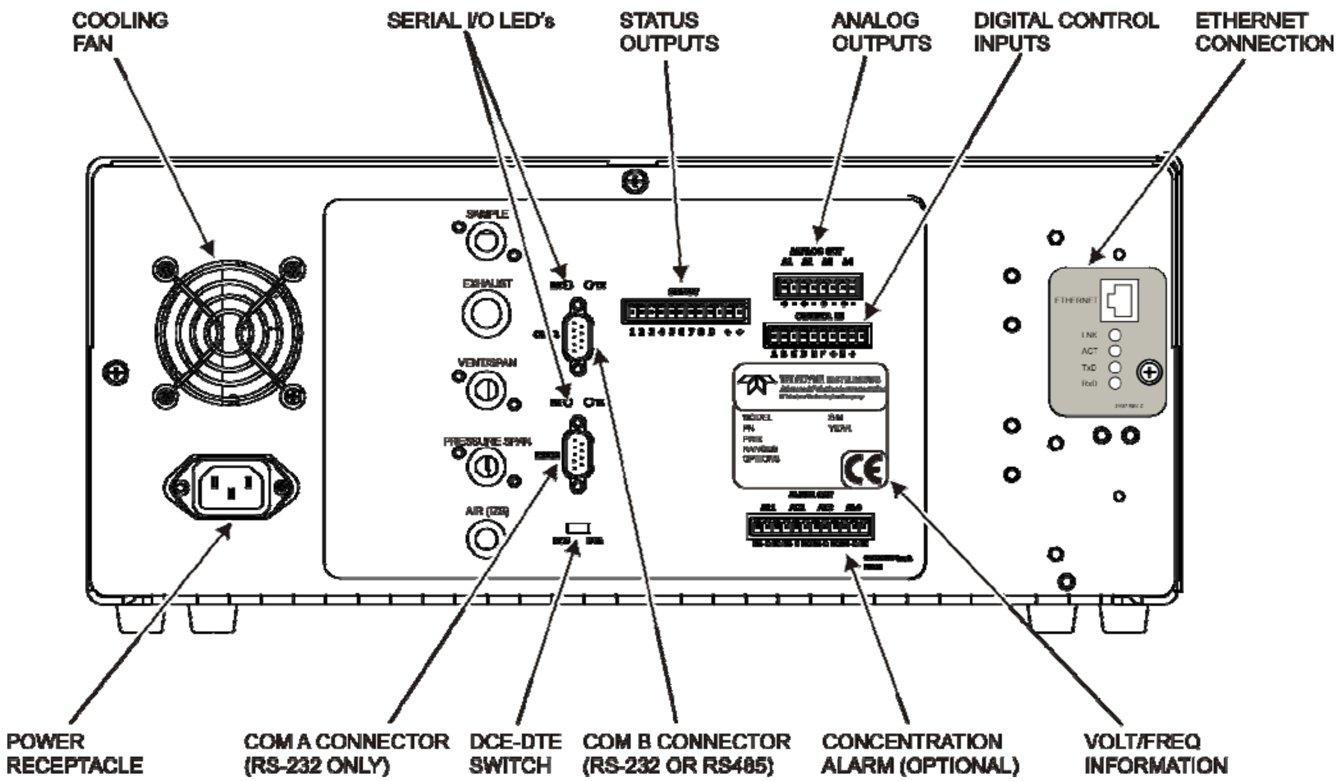


Figure 3-2: Rear Panel Layout

Table 3-2: Inlet / Outlet Connector Nomenclature

REAR PANEL LABEL	FUNCTION
SAMPLE	Connect a gas line from the source of sample gas here. Calibration gases are also inlet here on units without zero/span/shutoff valve options installed.
EXHAUST	Connect an exhaust gas line of not more than 10 meters long here that leads outside the shelter or immediate area surrounding the instrument.
Pressure Span	On units with zero/span/shutoff valve options installed, connect a gas line to the source of calibrated span gas here.
Vent/Span	Span gas vent outlet for units with zero/span/shutoff valve options installed. Connect an exhaust gas line of not more than 10 meters long here that leads outside the shelter or immediate area surrounding the instrument.
IZS	Internal Zero Air: On units with zero/span/shutoff valve options installed but no internal zero air scrubber attach a gas line to the source of zero air here.

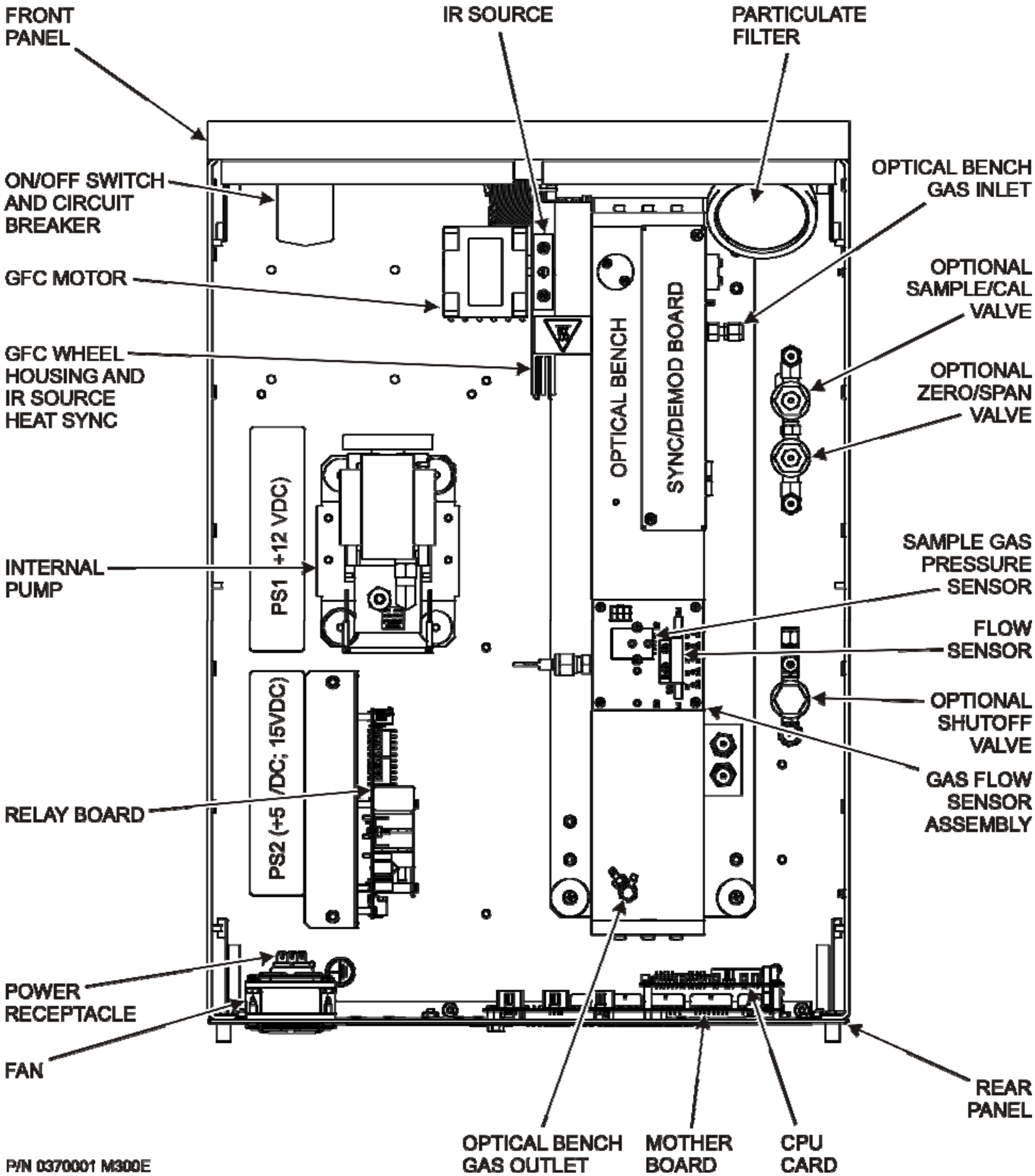


Figure 3-3: Internal Layout – M300E

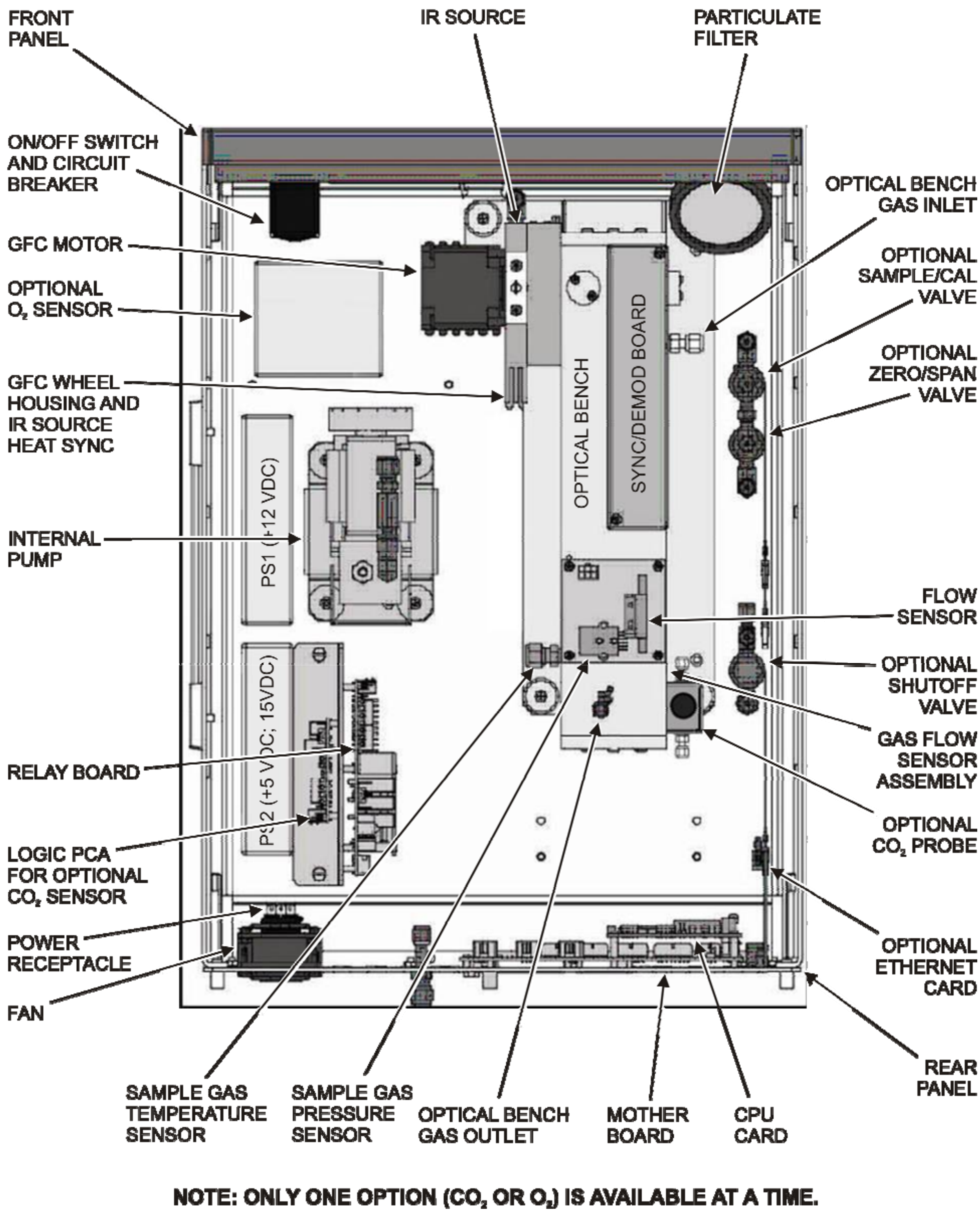


Figure 3-4: Internal Layout – M300EM with CO_2 and O_2 Sensor Option

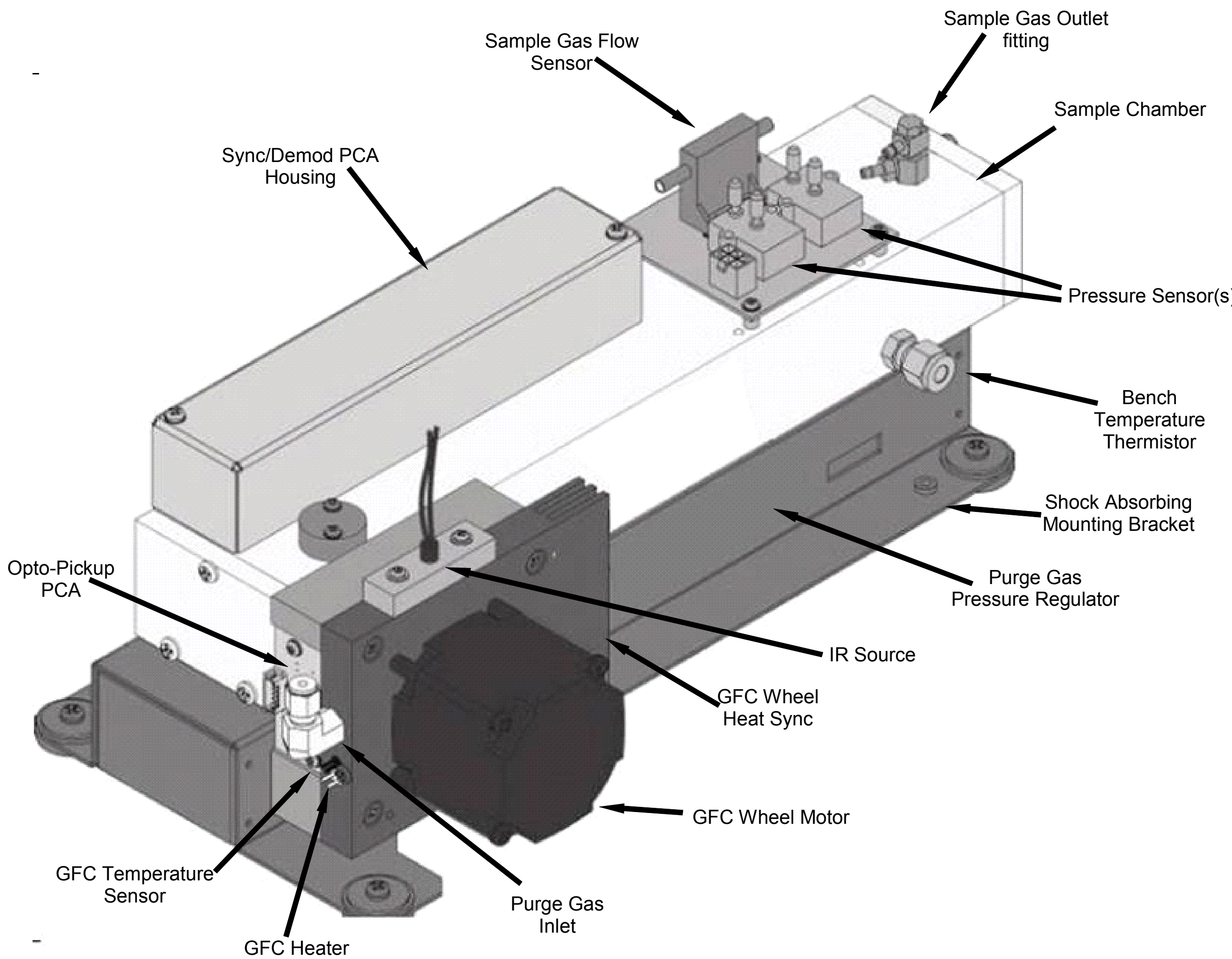


Figure 3-5: Optical Bench Layout

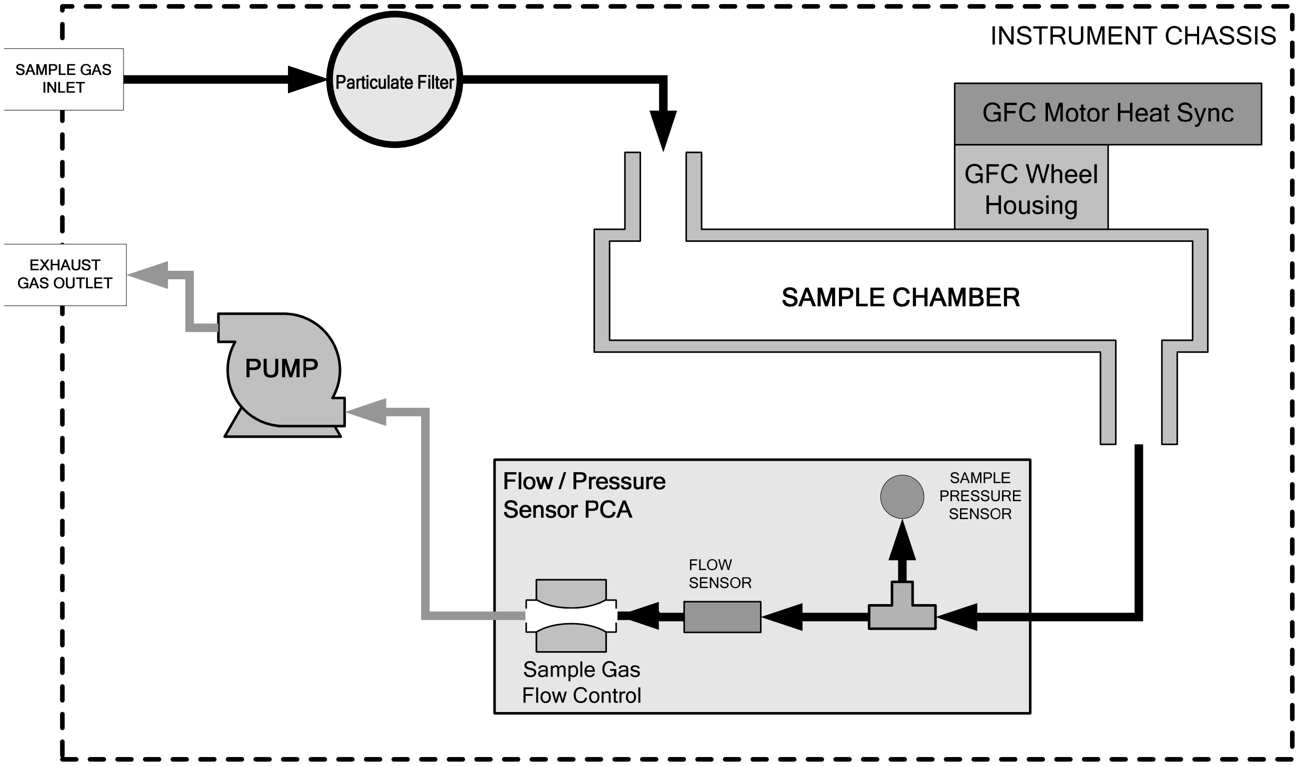


Figure 3-6: M300E/EM Internal Gas Flow (Basic Configuration)

NOTE
For pneumatic diagrams of M300E/EM Analyzer with various calibration valve options, see Section 5.6.

3.2. UNPACKING THE M300E/EM ANALYZER

CAUTION
GENERAL SAFETY HAZARD
To avoid personal injury, always use two persons to lift and carry the M300E/EM.

CAUTION
ELECTRICAL SHOCK HAZARD
Never disconnect PCAs, wiring harnesses or electronic subassemblies while under power.

CAUTION – Avoid Warranty Invalidation

Printed circuit assemblies (PCAs) are sensitive to electro-static discharges too small to be felt by the human nervous system. Damage resulting from failure to use ESD protection when working with electronic assemblies will void the instrument warranty.

See *A Primer on Electro-Static Discharge* in this manual for more information on preventing ESD damage.

NOTE
It is recommended that you store shipping containers/materials for future use if/when the instrument should be returned to the factory for repair and/or calibration serivce. See Warranty section in this manual and shipping procedures on our Website at http://www.teledyne-api.com under Customer Support > Return Authorization.

1. Verify that there is no apparent external shipping damage. If damage has occurred, please advise the shipper first, then Teledyne API.
2. Included with your analyzer is a printed record (*Final Test and Validation Data Sheet: M300E PN 04307; M300EM PN 04311)* of the final performance characterization performed on your instrument at the factory. This record is an important quality assurance and calibration record for this instrument. It should be placed in the quality records file for this instrument.
3. Carefully remove the top cover of the analyzer and check for internal shipping damage by:
   - Removing the setscrew located in the top, center of the Front panel;
   - Removing the two flat head, Phillips screws on the sides of the instrument (one per side towards the rear);
   - Sliding the cover backwards until it clears the analyzer's front bezel, and;
   - Lifting the cover straight up.
4. Inspect the interior of the instrument to make sure all circuit boards and other components are in good shape and properly seated.
5. Check the connectors of the various internal wiring harnesses and pneumatic hoses to make sure they are firmly and properly seated.
6. Verify that all of the optional hardware ordered with the unit has been installed. These are listed on the paperwork accompanying the analyzer.

3.2.1. **VENTILATION CLEARANCE**

Whether the analyzer is set up on a bench or installed into an instrument rack, be sure to leave sufficient ventilation clearance.

Table 3-3: Ventilation Clearance

AREA	MINIMUM REQUIRED CLEARANCE
Back of the instrument	4 in.
Sides of the instrument	1 in.
Above and below the instrument	1 in.

Various rack mount kits are available for this analyzer. See Section 5.2 of this manual for more information.

3.3. **ELECTRICAL CONNECTIONS**

NOTE

To maintain compliance with EMC standards, it is required that the cable length be no greater than 3 meters for all I/O connections, which include Analog In, Analog Out, Status Out, Control In, Ethernet/LAN, USB, RS-232, and RS-485.

3.3.1. **POWER CONNECTION**

Attach the power cord to the analyzer and plug it into a power outlet capable of carrying at least 10 A current at your AC voltage and that it is equipped with a functioning earth ground.

CAUTION

ELECTRICAL SHOCK HAZARD

High Voltages are present inside the analyzer's case.

Power connection must have functioning ground connection.

Do not defeat the ground wire on power plug.

Turn off analyzer power before disconnecting or connecting electrical subassemblies.

Do not operate with cover off.

CAUTION

GENERAL SAFETY HAZARD

The M300E/EM Analyzer can be configured for both 100-130 V and 210-240 V at either 47 Hz or 63 Hz.

To avoid damage to your analyzer, make sure that the AC power voltage matches the voltage indicated on the analyzer's serial number label tag (See Figure 3-2) before plugging the M300E/EM into line power.

3.3.2. **ANALOG OUTPUT CONNECTIONS**

The M300E is equipped with several analog output channels accessible through a connector on the back panel of the instrument. The standard configuration for these outputs is mVDC. An optional current loop output is available for each.

When the instrument is in its default configuration, channels A1 and A2 output a signal that is proportional to the CO concentration of the sample gas. Either can be used for connecting the analog output signal to a chart recorder or for interfacing with a datalogger.

Output A3 is only used on the M300E/EM if the optional CO_2 or O_2 sensor is installed.

Channel A4 is special. It can be set by the user (see Section 7.4.6) to output any one of the parameters accessible through the **<TST TST>** keys of the units sample display.

To access these signals attach a strip chart recorder and/or data-logger to the appropriate analog output connections on the rear panel of the analyzer.

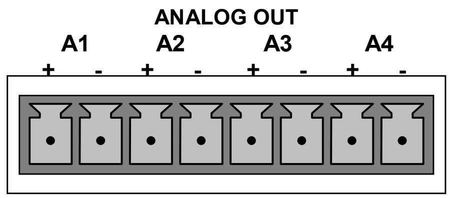


Figure 3-7: Analog Output Connector

Table 3-4: Analog Output Pin-Outs

PIN	ANALOG OUTPUT	VOLTAGE SIGNAL	CURRENT SIGNAL
1	A1	V Out	I Out +
2		Ground	I Out -
3	A2	V Out	I Out +
4		Ground	I Out -
5	A3 (Only used if CO_2 or O_2 Sensor is installed)	V Out	I Out +
6		Ground	I Out -
7	A4	V Out	I Out +
8		Ground	I Out -

3.3.3. **CONNECTING THE STATUS OUTPUTS**

The status outputs report analyzer conditions via optically isolated NPN transistors, which sink up to 50 mA of DC current. These outputs can be used interface with devices that accept logic-level digital inputs, such as Programmable Logic Controllers (PLCs). Each status bit is an open collector output that can withstand up to 40 VDC. All of the emitters of these transistors are tied together and available at D.

NOTE

Most PLC's have internal provisions for limiting the current that the input will draw from an external device. When connecting to a unit that does not have this feature, an external dropping resistor must be used to limit the current through the transistor output to less than 50 mA.

At 50 mA, the transistor will drop approximately 1.2V from its collector to emitter.

The status outputs are accessed via a 12-pin connector on the analyzer's rear panel labeled STATUS (see Figure 3-2). Pin-outs for this connector are:

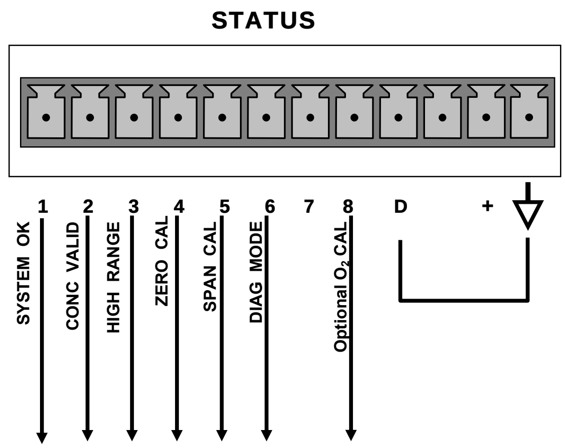


Figure 3-8: Status Output Connector

Table 3-5: Status Output Signals

REAR PANEL LABEL	STATUS DEFINITION	CONDITION
1	SYSTEM OK	ON if no faults are present.
2	CONC VALID	OFF any time the **HOLD OFF** feature is active, such as during calibration or when other faults exist possibly invalidating the current concentration measurement (example: sample flow rate is outside of acceptable limits). ON if concentration measurement is valid.
3	HIGH RANGE	ON if unit is in high range of either the **DUAL** or **AUTO** range modes.
4	ZERO CAL	ON whenever the instrument's **ZERO** point is being calibrated.
5	SPAN CAL	ON whenever the instrument's **SPAN** point is being calibrated.
6	DIAG MODE	ON whenever the instrument is in **DIAGNOSTIC** mode.
7	CO_2 CAL	If this analyzer is equipped with an optional CO_2 sensor, this Output is ON when that sensor is in calibration mode. Otherwise this output is unused.
8	O_2 CAL	If this analyzer is equipped with an optional O_2 sensor, this Output is ON when that sensor is in calibration mode. Otherwise this output is unused.
D	EMITTER BUS	The emitters of the transistors on pins 1-8 are bussed together.
	SPARE	
+	DC POWER	+ 5 VDC, 300 mA source (combined rating with Control Output, if used).
	Digital Ground	The ground level from the analyzer's internal DC power supplies.

3.3.4. **CONNECTING THE CONTROL INPUTS**

If you wish to use the analyzer to remotely activate the zero and span calibration modes, several digital control inputs are provided through a 10-pin connector labeled **CONTROL IN** on the analyzer's rear panel.

There are two methods for energizing the control inputs. The internal +5V available from the pin labeled "+" is the most convenient method. However, if full isolation is required, an external 5 VDC power supply should be used.

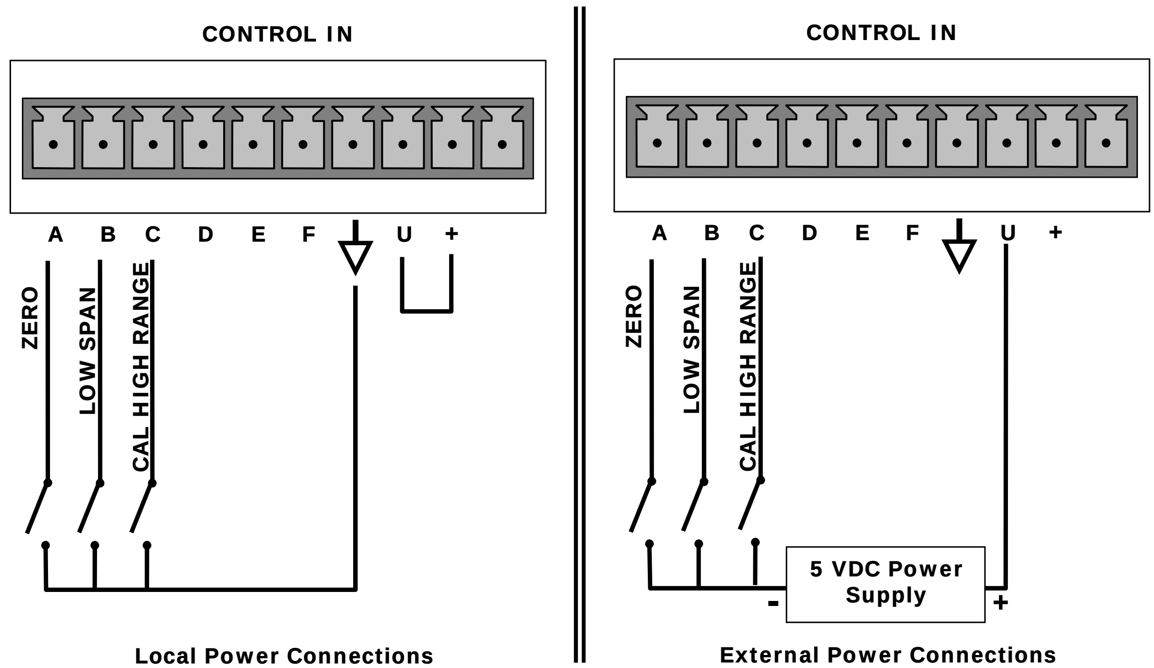


Figure 3-9: Control Input Connector

Table 3-6: Control Input Signals

INPUT #	STATUS DEFINITION	ON CONDITION
A	**REMOTE ZERO CAL**	The analyzer is placed in Zero Calibration mode. The mode field of the display will read **ZERO CAL R**.
B	**REMOTE SPAN CAL**	The analyzer is placed in span calibration mode as part of performing a low span (midpoint) calibration. The mode field of the display will read **LO CAL R**.
C	**REMOTE CAL HIGH RANGE**	The analyzer is forced into high range for zero or span calibrations. This only applies when the range mode is either DUAL or AUTO. The mode field of the display will read **HI CAL R**.
D, E & F	SPARE	
⏚	Digital Ground	The ground level from the analyzer's internal DC power supplies (same as chassis ground).
U	External Power input	Input pin for +5 VDC required to activate pins A – F.
+	5 VDC output	Internally generated 5V DC power. To activate inputs A – F, place a jumper between this pin and the "U" pin. The maximum amperage through this port is 300 mA (combined with the analog output supply, if used).

3.3.5. **CONNECTING THE SERIAL PORTS**

If you wish to utilize either of the analyzer's two serial interface COMM ports, refer to Section 8 for instructions on their configuration and usage.

3.3.6. **CONNECTING TO A LAN OR THE INTERNET**

If your unit has a Teledyne API's Ethernet card, plug one end into the 7' CAT5 cable supplied with the option into the appropriate place on the back of the analyzer and the other end into any nearby Ethernet access port.

NOTE

The M300E/EM firmware supports dynamic IP addressing or DHCP.

If your network also supports DHCP, the analyzer will automatically configure its LAN connection appropriately (see Section 8.4.2).

If your network does not support DHCP, see Section 8.4.3 for instructions on manually configuring the LAN connection.

3.3.7. **CONNECTING TO A MULTIDROP NETWORK**

If your unit has a Teledyne API's RS-232 multidrop card, see Section 8.2 for instructions on setting it up.

3.4. **PNEUMATIC CONNECTIONS**

CAUTION

GENERAL SAFETY HAZARD

CARBON MONOXIDE (CO) IS A TOXIC GAS.

Obtain a Material Safety Data Sheet (MSDS) for this material. Read and rigorously follow the safety guidelines described there.

Do not vent calibration gas and sample gas into enclosed areas.

3.4.1. **CALIBRATION GASES**

3.4.1.1. **Zero Air**

Zero air is a gas that is similar in chemical composition to the earth's atmosphere but scrubbed of all components that might affect the analyzers readings, in this case CO and water vapor. If your analyzer is equipped with an IZS or External Zero Air scrubber option, it is capable of creating zero air.

If the analyzer is NOT equipped with the optional CO_2 sensor, zero air should be scrubbed of CO_2 as well as this gas can also have an interfering effect on CO measurements.

For analyzers without an IZS or external zero air scrubber option, a zero air generator such as the Teledyne API's M701 can be used.

3.4.1.2. **Span Gas**

Span gas is a gas specifically mixed to match the chemical composition of the type of gas being measured at near full scale of the desired measurement range. In the case of CO measurements made with the M300E/EM Analyzer, it is recommended that you use a span gas with a CO concentration equal to 80-90% of the measurement range for your application.

EXAMPLE: If the application is to measure between 0 ppm and 500 ppb, an appropriate span gas concentration would be 400-450 ppb CO in N2.

Some applications, such as EPA monitoring, require a multipoint calibration procedure where span gases of different concentrations are needed. We recommend using a bottle of calibrated CO gas of higher concentration in conjunction with a gas dilution calibrator such as a Teledyne API's M700. This type of calibrator precisely mixes a high concentration gas with zero air (both supplied externally) to accurately produce span gas of the correct concentration. Linearity profiles can be automated with this model and run unattended over night.

Cylinders of calibrated CO gas traceable to NIST-Standard Reference Material specifications (also referred to as SRMs or EPA protocol calibration gases) are commercially available. Table 3-7 lists specific NIST-SRM reference numbers for various concentrations of CO.

Table 3-7: NIST-SRM's Available for Traceability of CO Calibration Gases

NIST-SRM	TYPE	NOMINAL CONCENTRATION
1680b	CO in N_2	500 ppm
1681b	CO in N_2	1000 ppm
2613a	CO in Zero Air	20 ppm
2614a	CO in Zero Air	45 ppm
2659a[1]	O_2 in N_2	21% by weight
2626a	CO_2 in N_2	4% by weight
2745*	CO_2 in N_2	16% by weight

[1] Used to calibrate optional O_2 sensor.
[2] Used to calibrate optional CO_2 sensor.

3.4.2. PNEUMATIC CONNECTIONS TO M300E/EM BASIC CONFIGURATION

NOTE

In order to prevent dust from getting into the gas flow channels of your analyzer, it was shipped with small plugs inserted into each of the pneumatic fittings on the back panel.

Make sure that all of these dust plugs are removed before attaching exhaust and supply gas lines.

See Figure 3-2 and Table 3-2 for the location and descriptions of the various pneumatic inlets/outlets referred to in this section.

See Section 5.6 for information regarding the pneumatic setup of M300E/EM Analyzers with various optional calibration valve options in stalled

CAUTION

GENERAL SAFETY HAZARD

Sample and calibration gases should only come into contact with PTFE (Teflon), FEP, glass, stainless steel or brass.

The exhaust from the analyzer's internal pump MUST be vented outside the immediate area or shelter surrounding the instrument.

It is important to conform to all safety requirements regarding exposure to CO.

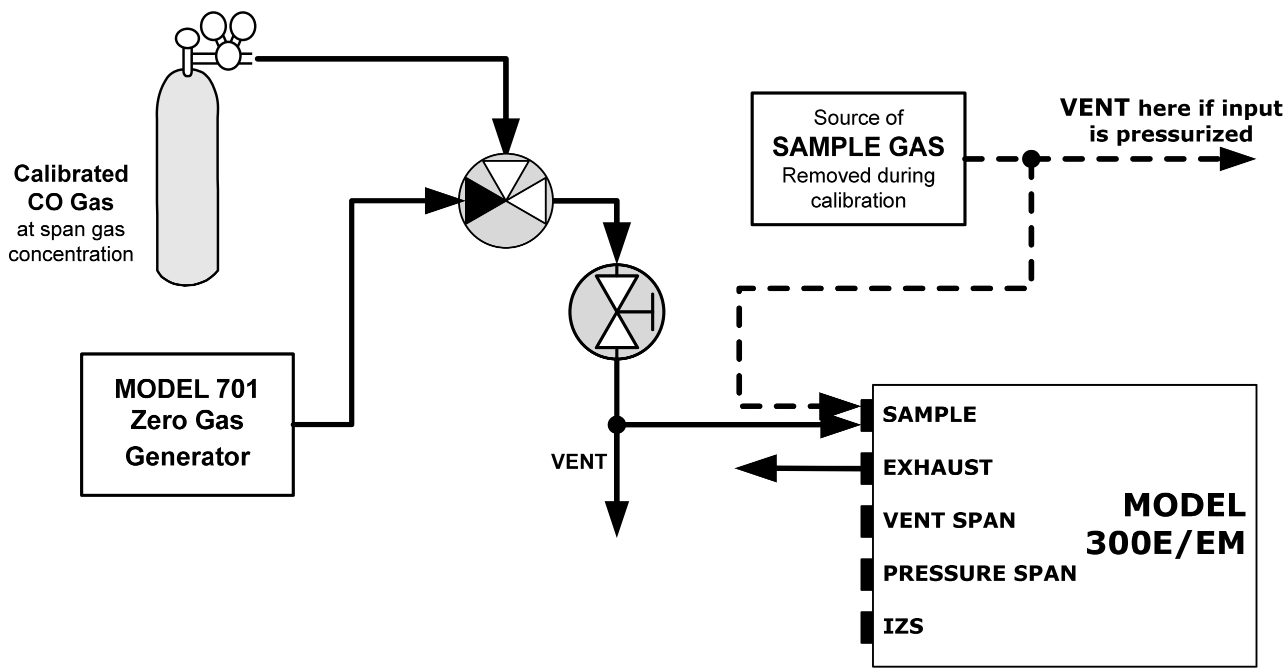


Figure 3-10: Pneumatic Connections–Basic Configuration–Using Bottled Span Gas

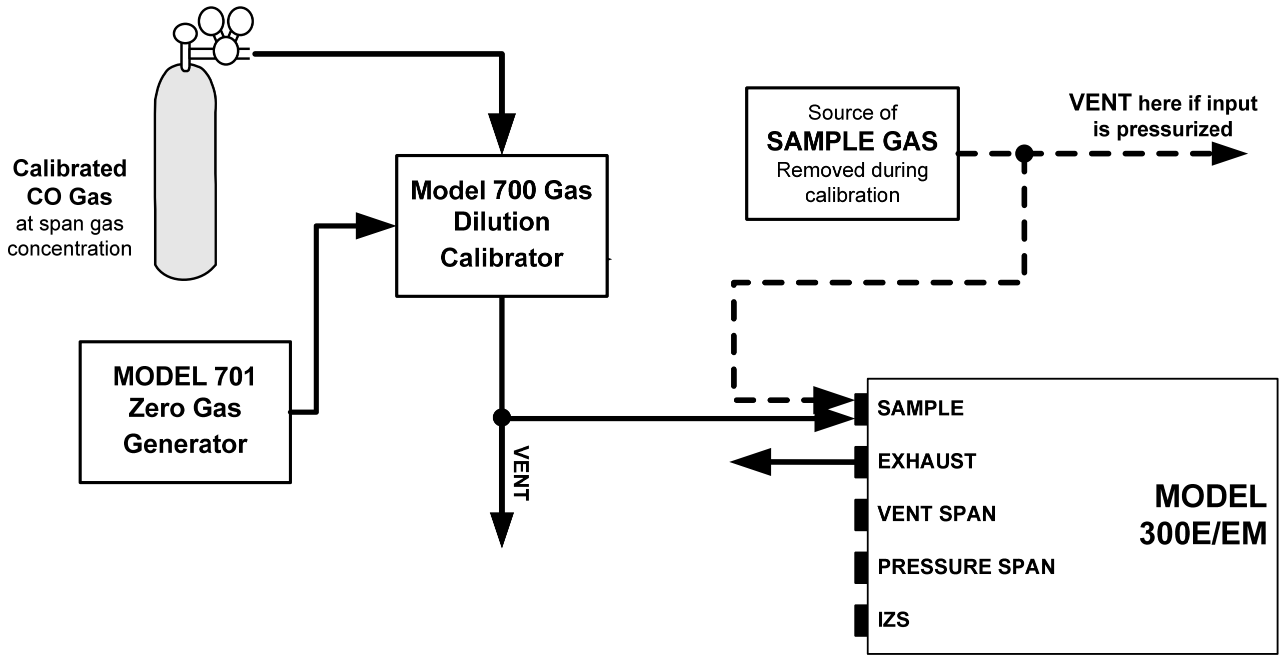


Figure 3-11: Pneumatic Connections–Basic Configuration–Using Gas Dilution Calibrator

3.4.2.1. **Sample Gas Source**

Attach a sample inlet line to the **SAMPLE** inlet port. The sample input line should not be more than 2 meters long.

- Maximum pressure of any gas at the sample inlet should not exceed 1.5 in-hg above ambient pressure and ideally should equal ambient atmospheric pressure.
- In applications where the sample gas is received from a pressurized manifold, a vent must be placed on the sample gas before it enters the analyzer.

3.4.2.2. **Calibration Gas Sources**

The source of calibration gas is also attached to the **SAMPLE** inlet, but only when a calibration operation is actually being performed.

> **NOTE**
>
> **Zero air and span gas inlets should supply their respective gases in excess of the 800 cc3/min demand of the analyzer.**

3.4.2.3. **Input Gas Venting**

The span gas, zero air supply and sample gas line MUST be vented in order to ensure that the gases input do not exceed the maximum inlet pressure of the analyzer as well as to prevent back diffusion and pressure effects. These vents should be:

- At least 0.2m long;
- No more than 2m long and;
- Vented outside the shelter or immediate area surrounding the instrument.

3.4.2.4. **Exhaust Outlet**

Attach an exhaust line to the analyzer's EXHAUST outlet fitting. The exhaust line should be:

- PTEF tubing; minimum O.D ¼";
- A maximum of 10 meters long;
- Vented outside the M300E/EM Analyzer's enclosure.

NOTE

Once the appropriate pneumatic connections have been made, check all pneumatic fittings for leaks using the procedures defined in Section 12.3.3.

NOTE

For information on attaching gas lines to M300E/EM Analyzers with various calibration valve options, see Section 5.6.

3.5. **INITIAL OPERATION**

NOTE

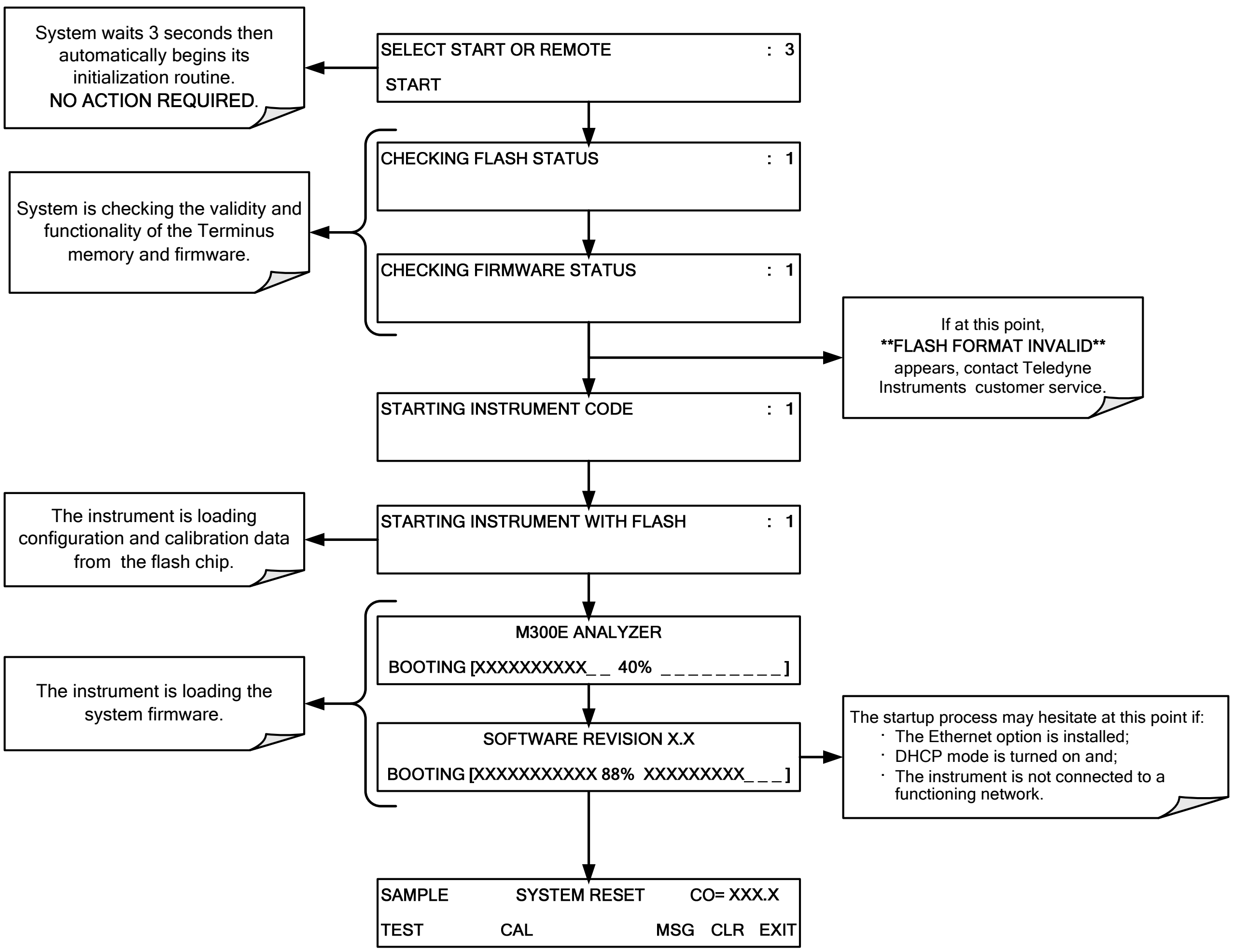
The analyzer's cover must be installed to ensure that the temperatures of the GFC Wheel and absorption cell assemblies are properly controlled.

If you are unfamiliar with the M300E/EM theory of operation, we recommend that you read Section **Error! Reference source not found.**. For information on navigating the analyzer's software menus, see the menu trees described in Appendix A.1.

3.5.1. **STARTUP**

After the electrical and pneumatic connections are made, turn on the instrument. The pump and exhaust fan should start immediately. The display should immediately display a single, horizontal dash in the upper left corner of the display. This will last approximately 30 seconds while the CPU loads the operating system.

Once the CPU has completed this activity it will begin loading the analyzer firmware and configuration data. During this process, astring of messages will appear on the analyzer's front panel display.



The analyzer should automatically switch to Sample Mode after completing the boot-up sequence and start monitoring CO gas.

3.5.2. WARM UP

The M300E/EM requires about 60 minutes warm-up time before reliable CO measurements can be taken. During that time, various portions of the instrument's front panel will behave as shown in Table 3-8. See Figure 3-1 for the layout.

Table 3-8: Front Panel Display during System Warm-Up

NAME	COLOR	BEHAVIOR	SIGNIFICANCE
Concentration Field	N/A	Displays current, compensated CO Concentration	This is normal operation.
Mode Field	N/A	Displays blinking "SAMPLE"	Instrument is in sample mode but is still in the process of warming up. (iDAS holdoff period is active)
STATUS LED's			
Sample	Green	On	Unit is operating in sample mode; front panel display is being updated. Flashes On/Off when adaptive filter is active
Cal	Yellow	Off	The instrument's calibration is not enabled.
Fault	Red	Blinking	The analyzer is warming up and hence out of specification for a fault-free reading. Various warning messages will appear.

3.5.3. WARNING MESSAGES

Because internal temperatures and other conditions may be outside the specified limits during the analyzer's warm-up period, the software will suppress most warning conditions for 30 minutes after power up. If warning messages persist after the 60 minutes warm-up period is over, investigate their cause using the troubleshooting guidelines in Section **Error! Reference source not found.**.

To view and clear warning messages, press:

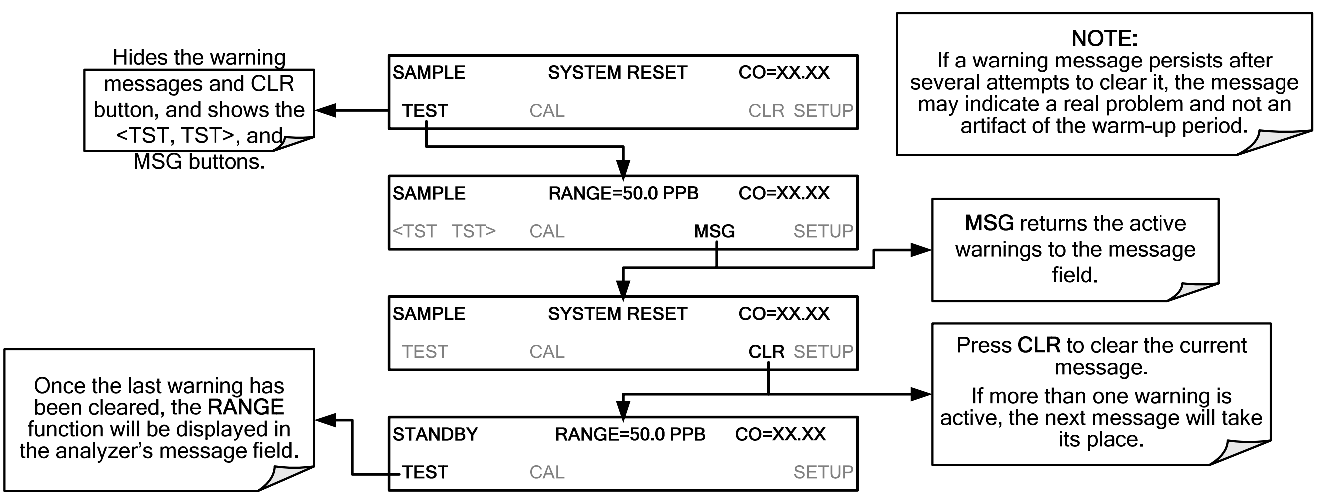


Table 3-6 lists brief descriptions of the warning messages that may occur during start up.

Table 3-9: Possible Warning Messages at Start-Up

Message	MEANING
ANALOG CAL WARNING	The instrument's A/D circuitry or one of its analog outputs is not calibrated.
BENCH TEMP WARNING	Optical bench temperature is outside the specified limits.
BOX TEMP WARNING	The temperature inside the M300E/EM chassis is outside the specified limits.
CANNOT DYN SPAN[2]	Remote span calibration failed while the dynamic span feature was set to turned on.
CANNOT DYN ZERO[3]	Remote zero calibration failed while the dynamic zero feature was set to turned on.
CONFIG INITIALIZED	Configuration was reset to factory defaults or was erased.
DATA INITIALIZED	iDAS data storage was erased.
FRONT PANEL WARN	CPU is unable to communicate with the front panel.
PHOTO TEMP WARNING	Photometer temperature outside of warning limits specified by PHOTO_TEMP_SET variable.
REAR BOARD NOT DET	Motherboard was not detected during power up.
RELAY BOARD WARN	CPU is unable to communicate with the relay PCA.
SAMPLE FLOW WARN	The flow rate of the sample gas is outside the specified limits.
SAMPLE PRESS WARN	Sample pressure outside of operational parameters.
SAMPLE TEMP WARN	The temperature of the sample gas is outside the specified limits.
SOURCE WARNING	The IR source may be faulty.
SYSTEM RESET[1]	The computer was rebooted.
WHEEL TEMP WARNING	The Gas Filter Correlation Wheel temperature is outside the specified limits.

[1] **Clears 45 minutes after power up.**
[2] **Clears the next time successful zero calibration is performed.**
[3] **Clears the next time successful span calibration is performed.**

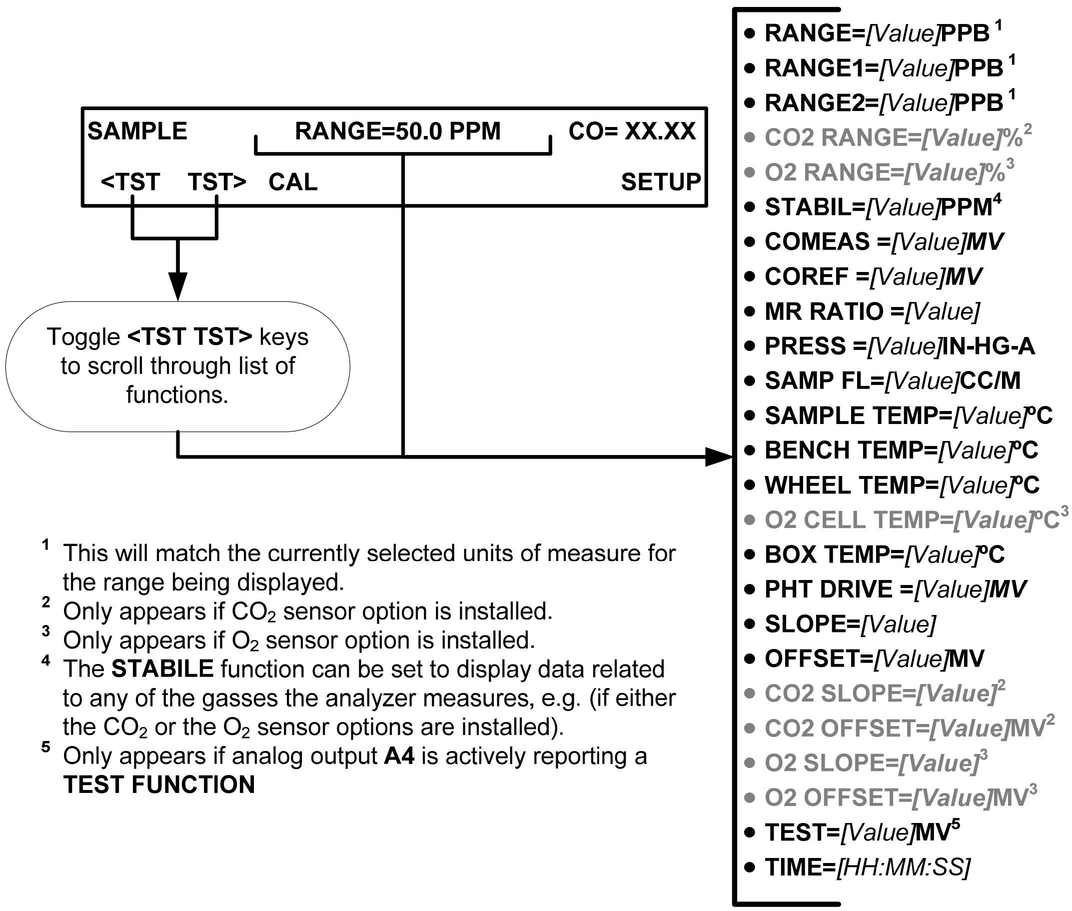
3.5.4. **FUNCTIONAL CHECK**

After the analyzer's components have warmed up for at least 60 minutes, verify that the software properly supports any hardware options that were installed.

For information on navigating through the analyzer's software menus, see the menu trees described in Appendix A.1.

- Check to make sure that the analyzer is functioning within allowable operating parameters.
  - Appendix C includes a list of test functions viewable from the analyzer's front panel as well as their expected values.
  - These functions are also useful tools for diagnosing performance problems with your analyzer (see Section 13.1.2).
  - The enclosed Final Test and Validation Data Sheet (P/N 04307) lists these values before the instrument left the factory.

To view the current values of these parameters press the following key sequence on the analyzer's front panel. Remember that until the unit has completed its warm-up these parameters may not have stabilized.



[1] This will match the currently selected units of measure for the range being displayed.
[2] Only appears if CO_2 sensor option is installed.
[3] Only appears if O_2 sensor option is installed.
[4] The **STABILE** function can be set to display data related to any of the gasses the analyzer measures, e.g. (if either the CO_2 or the O_2 sensor options are installed).
[5] Only appears if analog output **A4** is actively reporting a **TEST FUNCTION**

If your analyzer has an Ethernet card installed and your network is running a Dynamic Host Configuration Protocol (DHCP) software package, the Ethernet option will automatically configure its interface with your LAN.

- However, it is a good idea to check these settings to make sure that the DHCP has successfully downloaded the appropriate network settings from your network server (See Section 8.4.2).
- If your network is not running DHCP, you will have to configure the analyzer's interface manually (See Section 8.4.3).

3.6. INITIAL CALIBRATION OF THE M300E/EM

To perform the following calibration you must have sources for zero air and span gas available for input into the sample port on the back of the analyzer. See Section 3.4 for instructions for connecting these gas sources.

The initial calibration should be carried out using the same reporting range set up as used during the analyzer's factory calibration. This will allow you to compare your calibration results to the factory calibration as listed on the *Final Test and Validation Data Sheet*.

If both available iDAS parameters for a specific gas type are being reported via the instruments analog outputs e.g. **CONC1** and **CONC2** when the **DUAL** range mode is activated, separate calibrations should be carried out for each parameter.

- Use the **LOW** button when calibrating for **CONC1** (equivalent to **RANGE1**).
- Use the **HIGH** button when calibrating for **CONC2** (equivalent to **RANGE2**).

See Manual Addendum, P/N 06270 for more information on the configurable analog output reporting ranges.

NOTE

The following procedure assumes that the instrument does not have any of the available Valve Options installed.

See Section 9.3 for instructions for calibrating instruments possessing valve options.

3.6.1. INTERFERENTS FOR CO_2 MEASUREMENTS

It should be noted that the gas filter correlation method for detecting CO is subject to interference from a number of other gases that absorb IR in a similar fashion to CO. Most notable of these are water vapor, CO_2, N_2O (nitrous oxide) and CH_4 (methane). The M300E/EM has been successfully tested for its ability to reject interference from of these sources, however high concentrations of these gases can interfere with the instrument's ability to make low-level CO measurements.

For a more detailed discussion of this topic, see Section 11.2.1.3.

3.6.2. INITIAL CALIBRATION PROCEDURE FOR M300E/EM ANALYZERS WITHOUT OPTIONS

The following procedure assumes that:

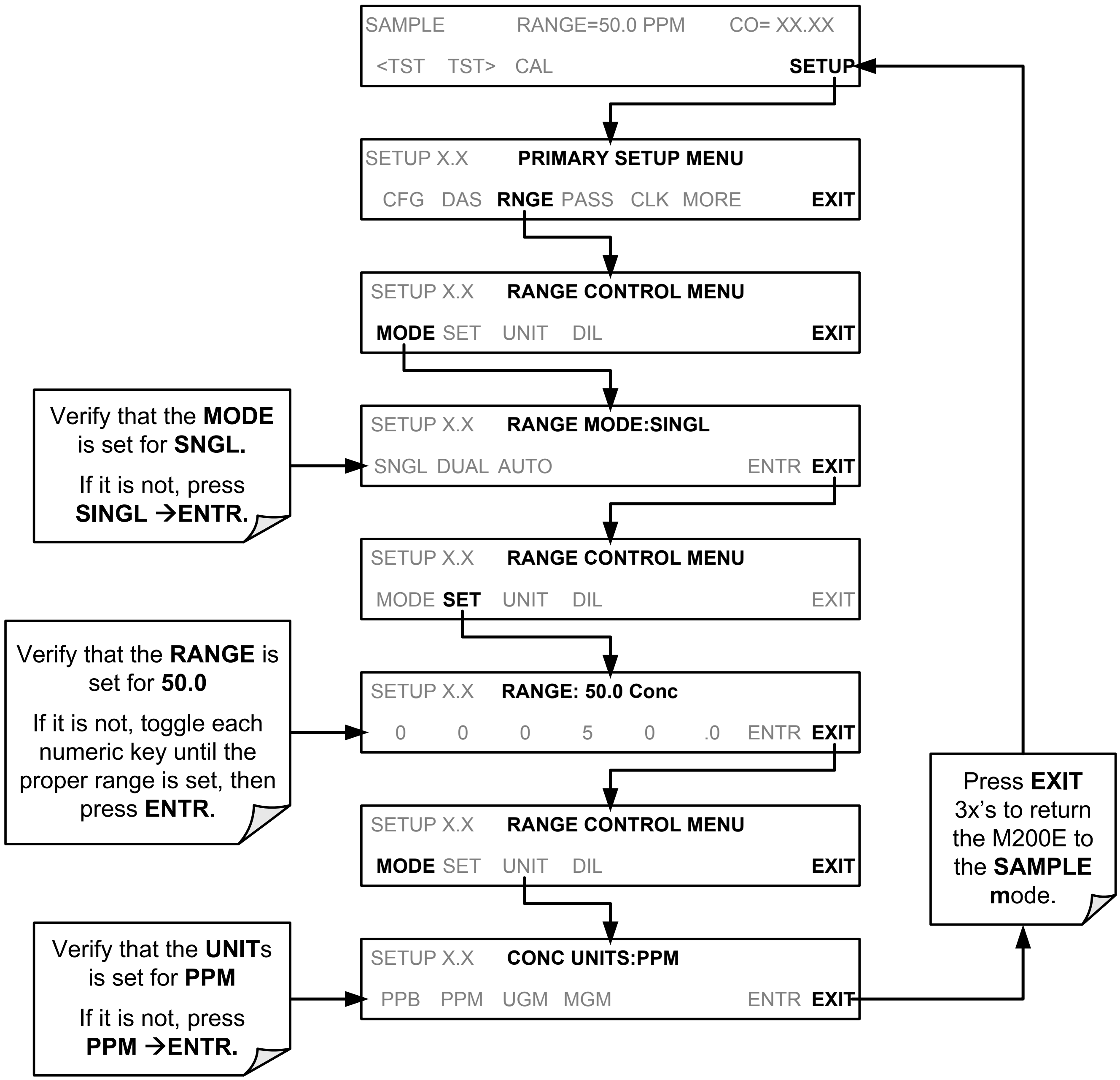
- The instrument DOES NOT have any of the available calibration valve or gas inlet options installed;
- Cal gas will be supplied through the SAMPLE gas inlet on the back of the analyzer (see Figure 3-2), and;
- The pneumatic setup matches that described in Section 3.4.2.

3.6.2.1. **Verifying the M300E/EM Reporting Range Settings**

While it is possible to perform the following procedure with any range setting we recommend that you perform this initial checkout using following reporting range settings:

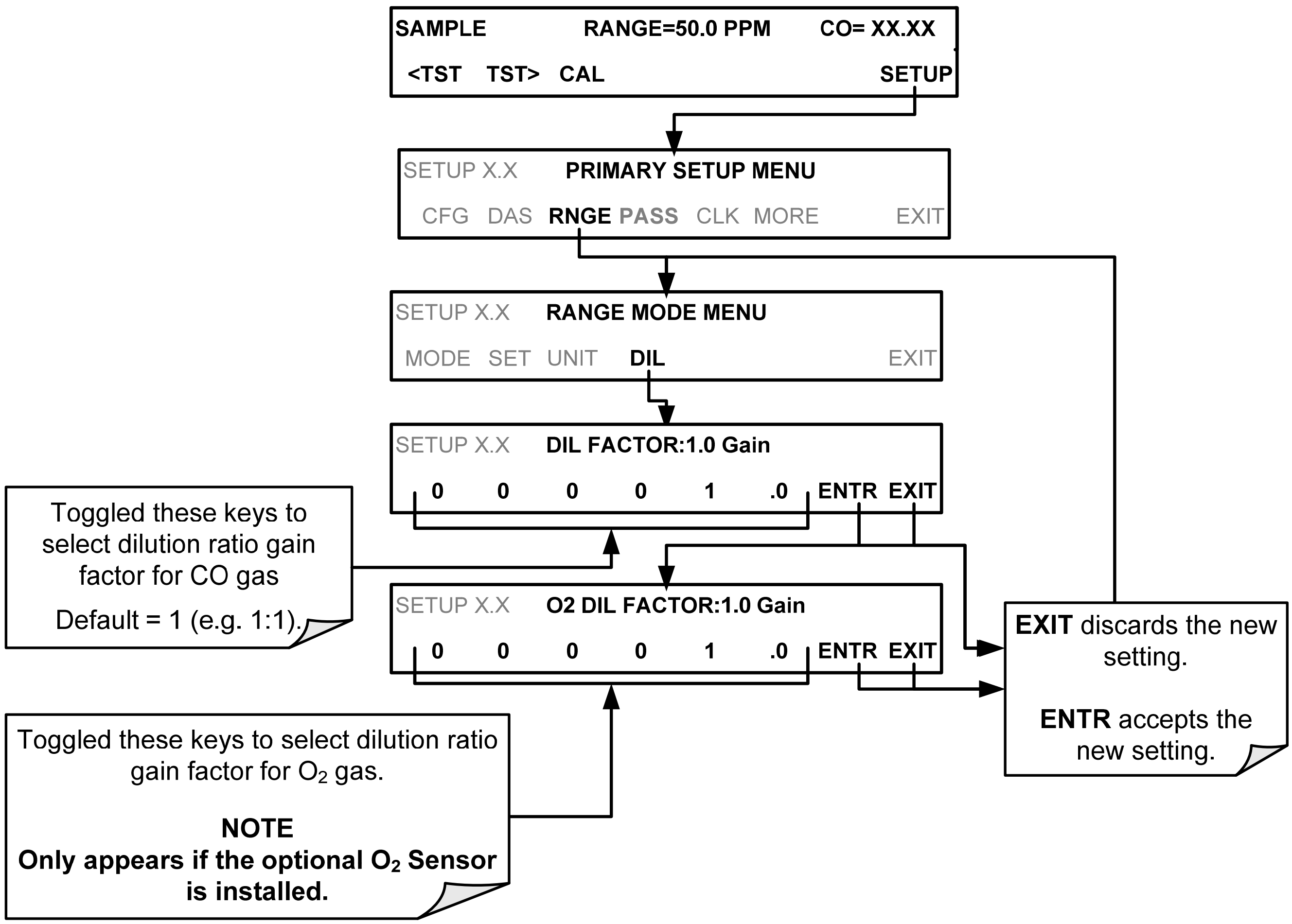
- Unit of Measure: PPM
- Analog Output Reporting Range: 50 ppm
- Mode Setting: SNGL

While these are the default setting for the M300E/EM Analyzer, it is recommended that you verify them before proceeding with the calibration procedure, by pressing:



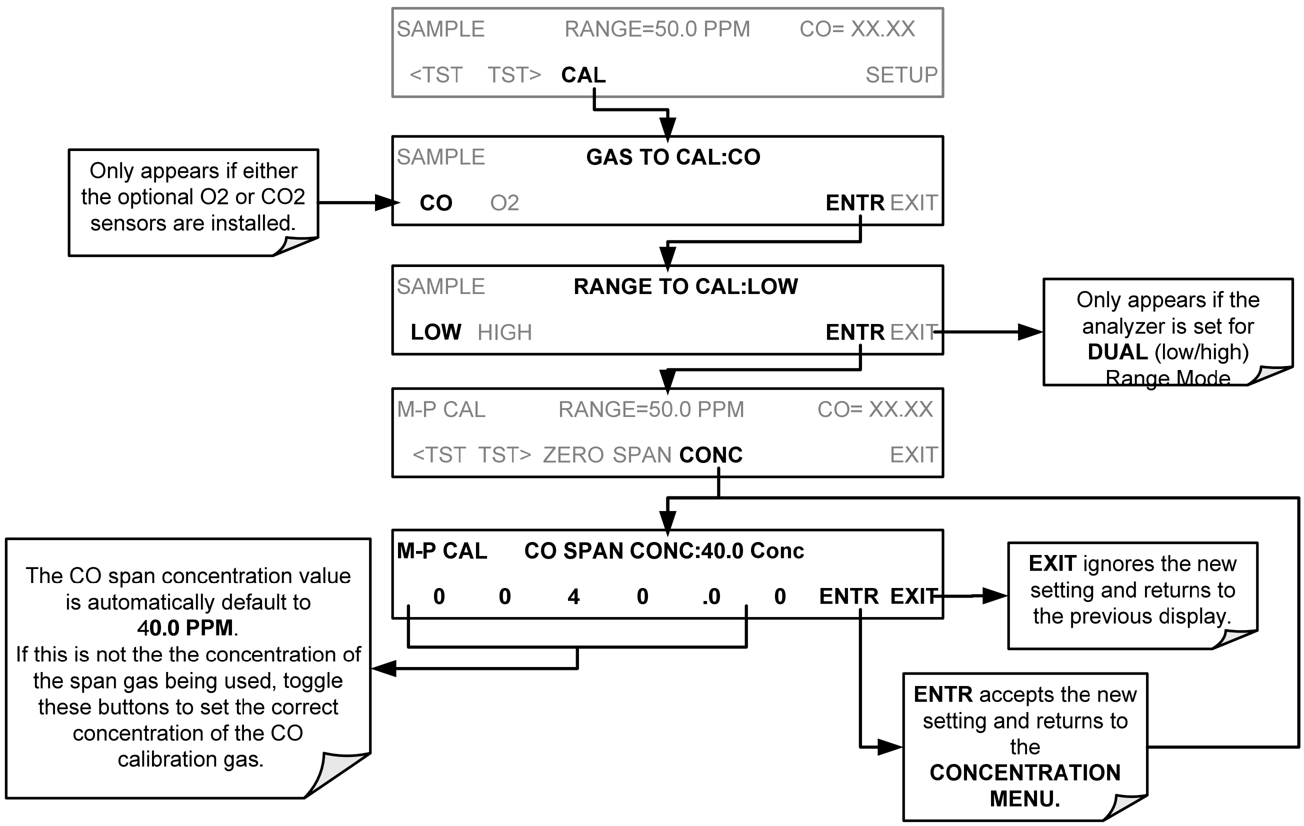
3.6.2.2. **Dilution Ratio Set Up**

If the dilution ration option is enabled on your M300E/EM Analyzer and your application involves diluting the sample gas before it enters the analyzer, set the dilution ration as follows:



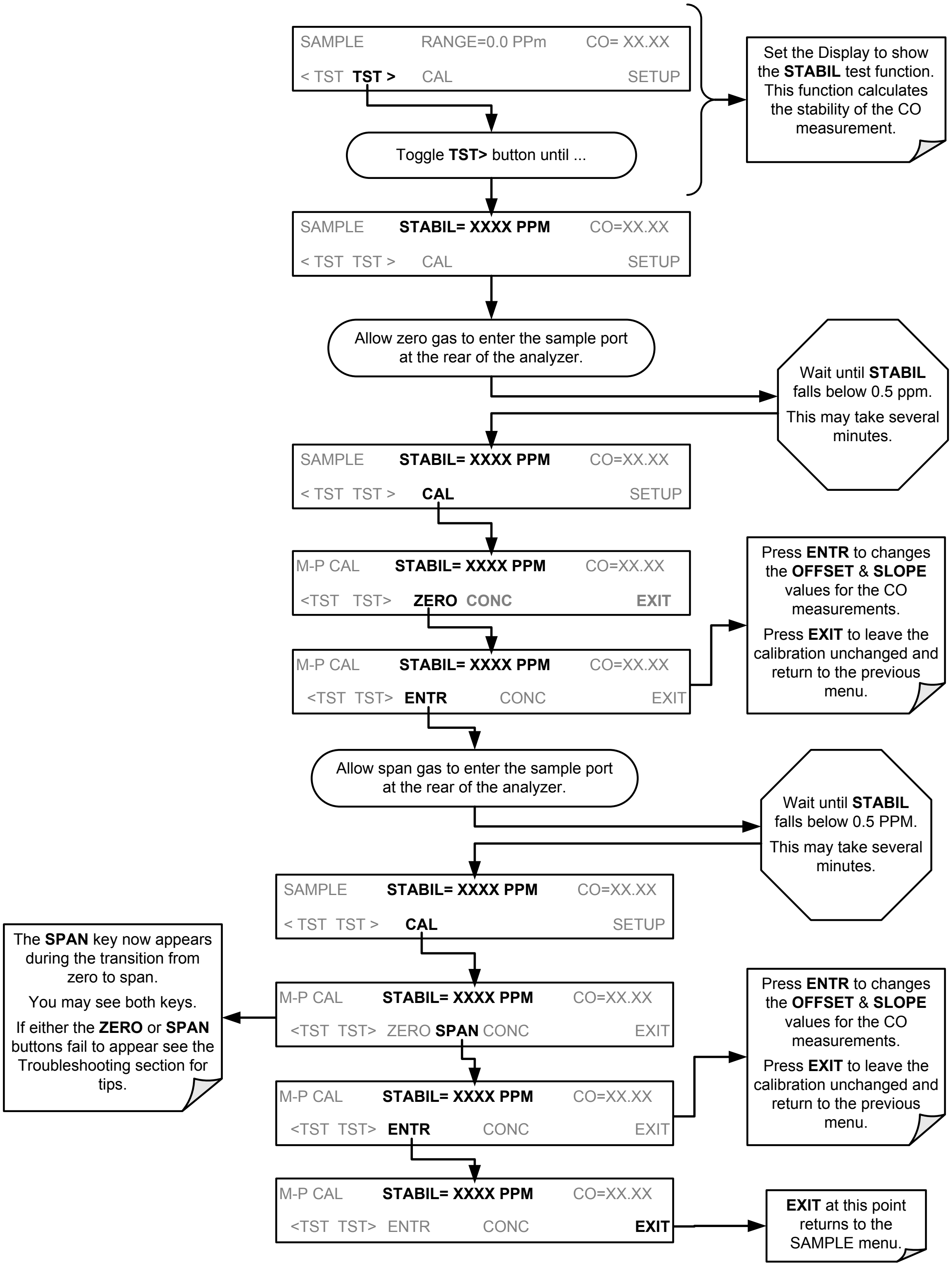
3.6.2.3. **Set CO Span Gas Concentration**

Set the expected CO pan gas concentration. This should be 80-90% of range of concentration range for which the analyzer's analog output range is set.



3.6.2.4. Zero/Span Calibration

To perform the zero/span calibration procedure, press:



3.6.3. O_2 SENSOR CALIBRATION PROCEDURE

If your M300E/EM is equipped with the optional O_2 sensor, this sensor should be calibrated during installation of the instrument. See Section 9.7.1 for instructions.

3.6.4. CO_2 SENSOR CALIBRATION PROCEDURE

If your M300E/EM is equipped with the optional CO_2 sensor, this sensor should be calibrated during installation of the instrument. See Section 9.7.2 for instructions.

The M300E/EM Analyzer is now ready for operation

NOTE

Once you have completed the above set-up procedures, please fill out the Quality Questionnaire that was shipped with your unit and return it to Teledyne API.

This information is vital to our efforts in continuously improving our service and our products.

THANK YOU.

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4. FREQUENTLY ASKED QUESTIONS

4.1. FAQ'S

The following is a list from the Teledyne API's Customer Service Department of the most commonly asked questions relating to the M300E/EM CO Analyzer.

Q: Why does the **ENTR** key sometimes disappear on the Front Panel Display?

A: During certain types of adjustments or configuration operations, the **ENTR** key will disappear if you select a setting that is nonsensical (such as trying to set the 24-hour clock to 25:00:00) or out of the allowable range for that parameter (such as selecting an iDAS hold off period of more than 20 minutes).

Once you adjust the setting in question to an allowable value, the **ENTR** key will re-appear.

Q: Why is the **ZERO** or **SPAN** key not displayed during calibration?

A: The M300E/EM disables certain these keys expected span or zero value entered by the users is too different from the gas concentration actually measured value at the time. This is to prevent the accidental recalibration of the analyzer to an out-of-range response curve.

EXAMPLE: The span set point is 40 ppm but gas concentration being measured is only 5 ppm.

For more information, see Sections 13.3.3 and 13.3.4.

Q: How do I enter or change the value of my Span Gas?

A: Press the **CONC** key found under the **CAL** or **CALS** buttons of the main SAMPLE display menus to enter the expected CO span concentration.

See Section 3.6.2.3 or Zero/Span Calibration3.6.2.4 for more information.

Q: Why does the analyzer not respond to span gas?

A: Section 13.3.3 has some possible answers to this question.

Q: Is there an optional midpoint calibration?

A: There is an optional mid-point linearity adjustment; however, midpoint adjustment is applicable only to applications where CO measurements are expected above 100 ppm. Call Teledyne API's Service Department for more information on this topic.

Q: What do I do if the concentration on the instrument's front panel display does not match the value recorded or displayed on my data logger even if both instruments are properly calibrated?

A: This most commonly occurs for one of the following reasons:

- A difference in circuit ground between the analyzer and the data logger or a wiring problem;
- A scale problem with the input to the data logger.

  The analog outputs of the M300E/EM can be manually adjusted to compensate for either or both of these effects, see Section 7.4.5;
- The analog outputs are not calibrated, which can happen after a firmware upgrade.

  Both the electronic scale and offset of the analog outputs can be adjusted (see Section 7.4.3). Alternately, use the data logger itself as the metering device during calibrations procedures.

Q: How do I perform a leak check?

A: See Section 12.3.3.

Q: How do I measure the sample flow?

A: Sample flow is measured by attaching a calibrated rotameter, wet test meter, or other flow-measuring device to the sample inlet port when the instrument is operating. The sample flow should be 800 cm^3/min ±10%. See Section 12.3.4.

Q: How long does the IR source last?

A: Typical lifetime is about 2-3 years.

Q: Can I automate the calibration of my analyzer?

A: Any analyzer with zero/span valve or IZS option can be automatically calibrated using the instrument's AutoCal feature. The setup of this option is located in Section 9.4.

Q: Can I use the IZS option to calibrate the analyzer?

A: Yes. However, whereas this may be acceptable for basic calibration checks, the IZS option is not permitted as a calibration source in applications following US EPA protocols.

To achieve highest accuracy, it is recommended to use cylinders of calibrated span gases in combination with a zero air source.

Q: My analyzer has the optional, user-configurable analog output channels. How do I program and use them?

A: Instructions for this can be found in Appendix E .

Q: What is the averaging time for an M300E/EM?

A: The default averaging time, optimized for ambient pollution monitoring, is 150 seconds for stable concentrations and 10 seconds for rapidly changing concentrations; See Section 11.5.12 for more information. However, it is adjustable over a range of 0.5 second to 200 seconds (please contact customer service for more information).

4.2. GLOSSARY

Term	Description/Definition
10BaseT	An Ethernet standard that uses twisted ("T") pairs of copper wires to transmit at 10 megabits per second (Mbps).
100BaseT	Same as 10BaseT except ten times faster (100 Mbps).
APICOM	Name of a remote control program offered by Teledyne-API to its customers.
ASSY	*Assembly.*
cm^3	metric abbreviation for *cubic centimeter*. Same as the obsolete abbreviation "cc".
Chemical formulas that may be included in this document:	
CO_2	carbon dioxide
C_3H_8	propane
CH_4	methane
H_2O	water vapor
HC	general abbreviation for hydrocarbon
HNO_3	nitric acid
H_2S	hydrogen sulfide
NO	nitric oxide
NO_2	nitrogen dioxide

Term	Description/Definition
NO_X	nitrogen oxides, here defined as the sum of NO and NO_2
NO_y	nitrogen oxides, often called odd nitrogen. The sum of NO, NO_2 (NO_X) plus other compounds such as HNO_3 Definitions vary widely and may include nitrate (NO_3), PAN, N_2O and other compounds.
NH_3	ammonia
O_2	molecular oxygen
O_3	ozone
SO_2	sulfur dioxide
DAS	*Data Acquisition System*
DIAG	*Diagnostics*, the diagnostic settings of the analyzer.
DHCP	*Dynamic Host Configuration Protocol.* A protocol used by LAN or Internet servers to automatically set up the interface protocols between themselves and any other addressable device connected to the network
DOM	*Disk On Module,* the analyzer's central storage area for analyzer firmware, configuration settings and data This is a 44-pin IDE flash disk that can hold up to 128MB.
DOS	*Disk Operating System*
DRAM	Dynamic Random Access Memory
DR-DOS	Digital Research DOS
Ethernet	a standardized (IEEE 802.3) computer networking technology for local area networks (LANs), facilitating communication and sharing resources
FLASH	flash memory is non-volatile, solid-state memory
GFC	*Gas Filter Correlation*
I^2C bus	a clocked, bi-directional, serial bus for communication between individual analyzer components
IC	*Integrated Circuit*, a modern, semi-conductor circuit that can contain many basic components such as resistors, transistors, capacitors etc in a miniaturized package used in electronic assemblies
IP	*Internet Protocol*
IZS	*Internal Zero Span*
LAN	*Local Area Network*
LCD	*Liquid Crystal Display*
LED	*Light Emitting Diode*
LPM	*Liters Per Minute*
M/R	*Measure/Reference*
NDIR	*Non-Dispersive Infrared*.
NIST-SRM	National *Institute of Standards and Technology - Standard Reference Material*.
PC	P*rinted Circuit Assembly*, the → PCB with electronic components, ready to use
PC/AT	*Personal Computer / Advanced Technology*.

Term	Description/Definition
PCB	*Printed Circuit Board*, the bare board without electronic component.
PLC	*Programmable Logic Controller*, a device that is used to control instruments based on a logic level signal coming from the analyzer
PFA	Per-Fluoro-Alkoxy, an inert polymer. One of the polymers that *du Pont* markets as *Teflon*®
PLD	*Programmable Logic Device*
PLL	*Phase Lock Loop*
PMT	*Photo Multiplier Tube*, a vacuum tube of electrodes that multiply electrons collected and charged to create a detectable current signal
P/N (or PN)	*Part Number*
PSD	*Prevention of Significant Deterioration*
PTFE	Poly-Tetra-Fluoro-Ethylene, a very inert polymer material used to handle gases that may react on other surfaces One of the polymers that *du Pont* markets as *Teflon*®
PVC	*Poly Vinyl Chloride*, a polymer used for downstream tubing
Rdg	Reading.
RS-232	specification and standard describing a serial communication method between two devices, DTE (Data Terminal Equipment) and DCE (Data Circuit-terminating Equipment), using a maximum cable-length of 50 feet.
RS-485	specification and standard describing a binary serial communication method among multiple devices at a data rate faster than RS-232 with a much longer distance between the host and the furthest device.
SAROAD	*Storage and Retrieval of Aerometric Data*.
SLAMS	*State and Local Air Monitoring Network Plan*.
SLPM	*Standard Liters Per Minute*; liters per minute of a gas at standard temperature and pressure.
STP	*Standard Temperature and Pressure*.
TCP/IP	*Transfer Control Protocol / Internet Protocol*, the standard communications protocol for Ethernet devices.
TEC	*Thermal Electric Cooler*.
USB	Universal Serial Bus is a standard connection method to establish communication between peripheral devices and a host controller, such as a mouse and/or keyboard and a personal computer.
VARS	*Variables*, the variable settings of the analyzer.
Z/S	*Zero / Span*.

5. OPTIONAL HARDWARE AND SOFTWARE

This includes a brief description of the hardware and software options available for the M300E/EM Gas Filter Correlation Carbon Monoxide Analyzer. For assistance with ordering these options please contact the Sales department of Teledyne – Advanced Pollution Instruments at:

TOLL-FREE:	800-324-5190
FAX:	858-657-9816
TEL:	858-657-9800
E-MAIL:	api-sales@teledyne.com
WEB SITE:	www.Teledyne-API.com

5.1. EXTERNAL PUMPS (OPTIONS 10A-10E, 11, 13)

A variety of optional pumps are available for the M300E/EM Analyzer. The range of available pump options meets all typical AC power supply standards while exhibiting the same pneumatic performance.

OPTION NUMBER	DESCRIPTION
10A	External Pump 115V @ 60 Hz
10B	External Pump 220V @ 50 Hz
10C	External Pump 220V @ 60 Hz
10D	External Pump 100V @ 50 Hz
10E	External Pump 100V @ 60 Hz
11	Pumpless, external Pump Pack/Rack
13	High Voltage Internal Pump 240V/50Hz

5.2. RACK MOUNT KITS (OPT 20 TO OPT 23)

There are several options for mounting the analyzer in standard 19” racks. The slides are three-part extensions, one mounts to the rack, one mounts to the analyzer chassis and the middle part remains on the rack slide when the analyzer is taken out. The analyzer locks into place when fully extended and cannot be pulled out without pushing two buttons, one on each side.

The rack mount brackets for the analyzer require that you have a support structure in your rack to support the weight of the analyzer. The brackets cannot carry the full weight of an analyzer and are meant only to fix the analyzer to the front of a rack, preventing it from sliding out of the rack accidentally.

OPTION NUMBER	DESCRIPTION
20A	Rack mount brackets with 26 in. chassis slides.
20B	Rack mount brackets with 24 in. chassis slides.
21	Rack mount brackets only.
23	Rack Mount for External Pump Pack (No Slides).

Each of these options permits the analyzer to be mounted in a standard 19" x 30" RETMA rack.

5.3. CARRYING STRAP/HANDLE (OPT 29)

The chassis of the M300E/EM Analyzer allows the user to attach a strap handle for carrying the instrument. The handle is located on the right side and pulls out to accommodate a hand for transport. When pushed in, the handle is nearly flush with the chassis, only protruding out about 9 mm (3/8”).

Figure 5-1: M300E/EM with Carrying Strap Handle and Rack Mount Brackets

Installing the strap handle prevents the use of the rack mount slides, although the rack mount brackets, Option 21, can still be used.

CAUTION

GENERAL SAFETY HAZARD

A fully configured M300E/EM with valve options weighs about 23 kg (51 pounds).

To avoid personal injury we recommend two persons lift and carry the analyzer.

Ensure to disconnect all cables and tubing from the analyzer before carrying it.

5.4. CURRENT LOOP ANALOG OUTPUTS (OPTION 41)

The current loop option adds isolated, voltage-to-current conversion circuitry to the analyzer’s analog outputs. It converts the DC voltage analog output to a current signal with 0-20 mA output current. The outputs can be scaled to any set of limits within that 0-20 mA range. However, most current loop applications call for either 2-20 mA or 4-20 mA range. All current loop outputs have a +5% over-range. Ranges with the lower limit set to more than 1 mA (e.g., 2-20 or 4-20 mA) also have a -5% under-range,

This option may be ordered separately for three of the analog outputs and can be installed as a retrofit.

Figure 5-2 provides installation instructions and illustrates a sample combination of one current output and two voltage outputs configuration. Section 5.4.1 provides instructions for converting current loop analog outputs to standard 0-to-5 VDC outputs. Information on calibrating or adjusting these outputs can be found in Section 7.4.3.5.

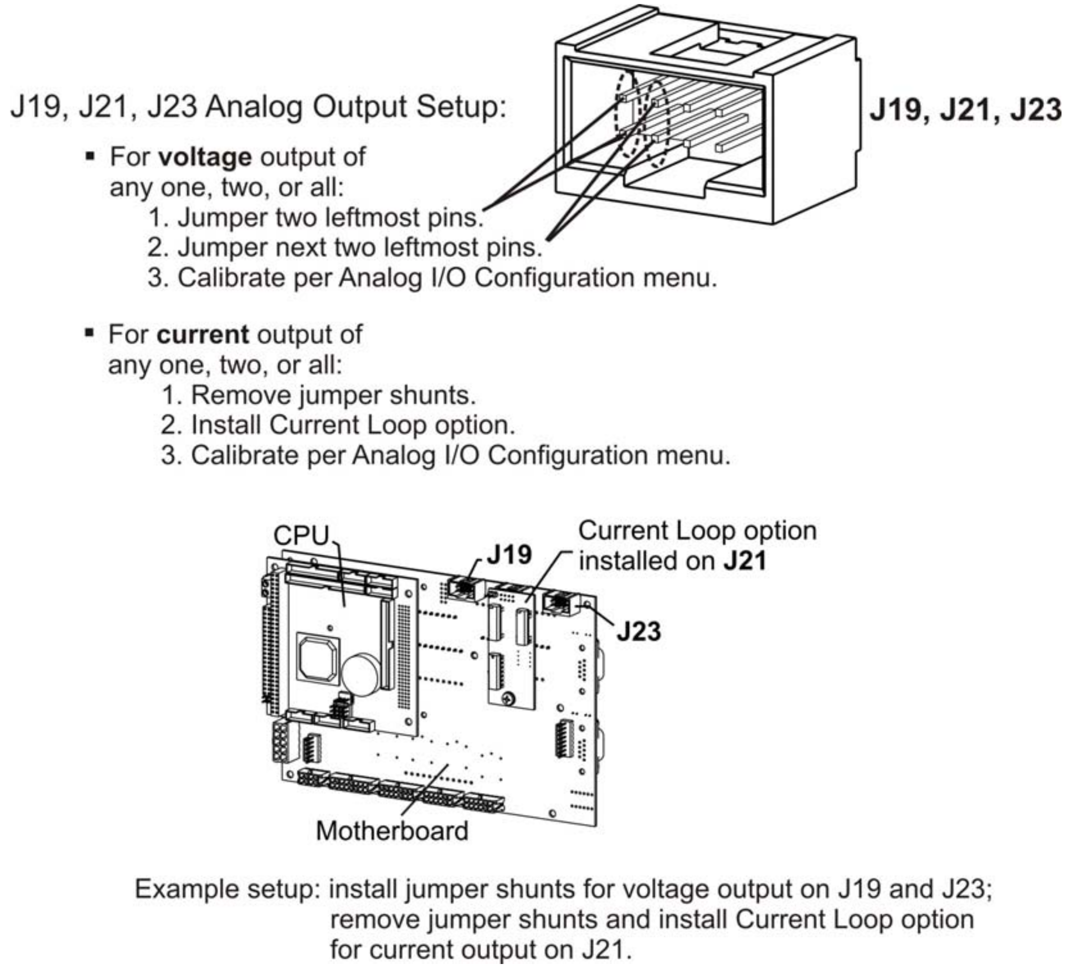

Figure 5-2: Current Loop Option Installed on the Motherboard

5.4.1. CONVERTING CURRENT LOOP ANALOG OUTPUTS TO STANDARD VOLTAGE OUTPUTS

NOTE

Servicing or handling of circuit components requires electrostatic discharge protection, i.e. ESD grounding straps, mats and containers. Failure to use ESD protection when working with electronic assemblies will void the instrument warranty.

See Section 14 for more information on preventing ESD damage.

To convert an output configured for current loop operation to the standard 0 to 5 VDC output operation:

1. Turn off power to the analyzer.
2. If a recording device was connected to the output being modified, disconnect it.
3. Remove the top cover.
   - Remove the screw located in the top, center of the front panel.
   - Remove the screws on both sides that fasten the top cover to the unit.
   - Slide the cover back and lift straight up.
4. Remove the screw holding the current loop option to the motherboard.

5. Disconnect the current loop option PCA from the appropriate connector on the motherboard (see Figure 5-2).
6. Each connector, J19 and J23, requires two shunts. Place one shunt on the two left most pins and the second shunt on the two pins next to it (see Figure 5-2).
   - 6 spare shunts (P/N CN0000132) were shipped with the instrument attached to JP1 on the back of the instruments keyboard and display PCA.
7. Reattach the top case to the analyzer.
8. The analyzer is now ready to have a voltage-sensing, recording device attached to that output.
9. Calibrate the analog output as described in Section 7.4.3.

5.5. EXPENDABLES AND SPARES KITS (OPTIONS 42A, 45)

Expendables Kit, Option 42A: one-year supply of replacement particulate filters (47mm diameter)

Spares Kit, Option 45: spare parts for one unit

5.6. CALIBRATION VALVES (OPTIONS 50A, 50B, 50E, 50H)

The M300E/EM Gas Filter Correlation Carbon Monoxide Analyzer has a variety of available options involving various valves for controlling the flow of calibration gases. From an operational and software standpoint, all of the options are the same, only the source of the span and zero gases are different.

5.6.1. GENERAL INFORMATION RELATED TO ALL VALVE OPTIONS

5.6.1.1. Gas Flow Rate

- The minimum span gas flow rate required is 800 cm^3/min; however, the US EPA recommends that there be an excess of flow at least 800 cm^3/min of calibration gas.
- Zero air will be supplied at ambient pressure from the local atmosphere.

5.6.1.2. Valve Control

The state of the various valves included in these options can be controlled as follows:

- Manually from the analyzer’s front panel by using the SIGNAL I/O controls located under the **DIAG** Menu (see Section 7.3),
- By activating the instrument’s AutoCal feature (see Section 9.4),
- Remotely by using the external digital control inputs (see Section 9.3.3.3), or
- Remotely through the RS-232/485/Ethernet serial I/O ports (see Appendix A-6 for the appropriate commands).

5.6.2. ZERO/SPAN VALVE (OPTION 50A)

This valve option is intended for applications where:

- Zero air is supplied by a zero air generator like the Teledyne API’s M701 and;
- Span gas is supplied by Gas Dilution Calibrator like the Teledyne API’s M700E or M702.

Internal zero/span and sample/cal valves control the flow of gas through the instrument, but because the generator and calibrator limit the flow of zero air and span gas, no shutoff valves are required.

5.6.2.1. **Internal Pneumatics (OPT 50A)**

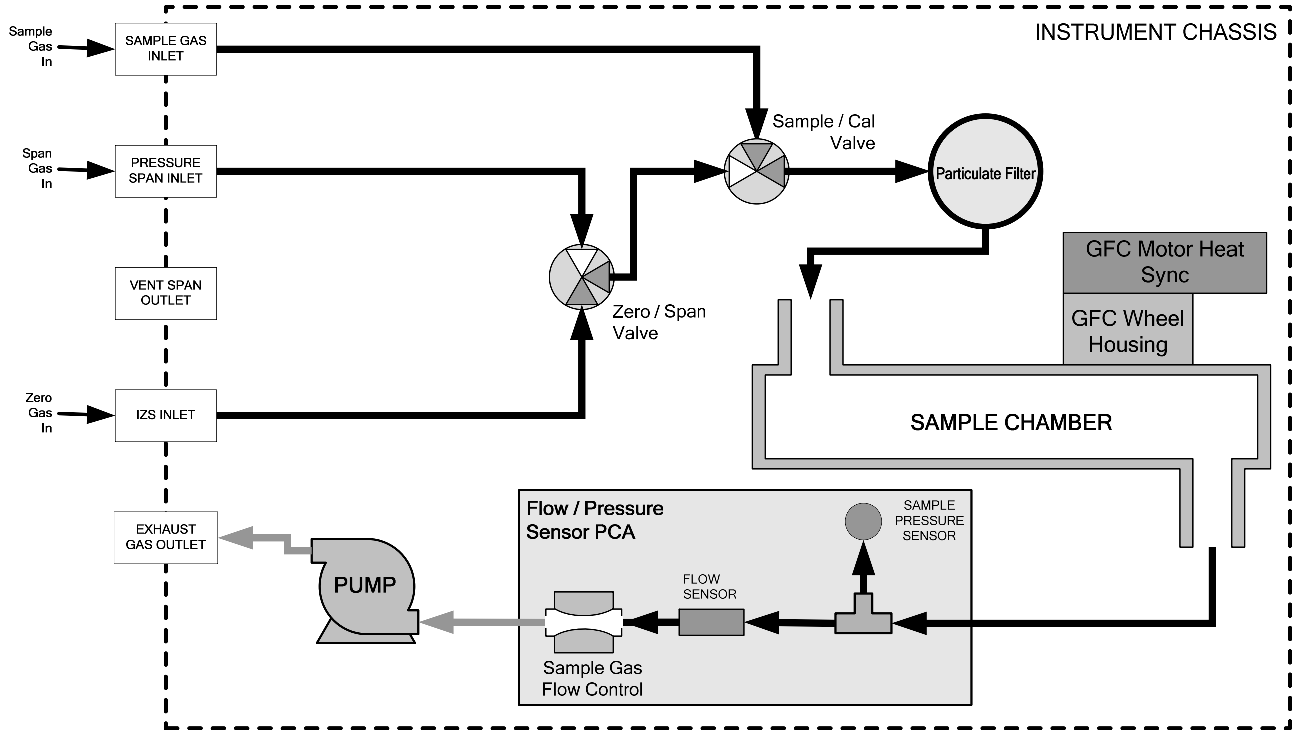

Figure 5-3: Internal Pneumatic Flow OPT 50A – Zero/Span Valves

Table 5-1: Zero/Span Valve Operating States for Option 52

MODE	VALVE	CONDITION
SAMPLE (Normal State)	Sample/Cal	Open to SAMPLE inlet
	Zero/Span	Open to IZS inlet
ZERO CAL	Sample/Cal	Open to ZERO/SPAN valve
	Zero/Span	Open to IZS inlet
SPAN CAL	Sample/Cal	Open to ZERO/SPAN valve
	Zero/Span	Open to PRESSURE SPAN inlet

5.6.2.2. **Pneumatic Set Up (OPT 50A)**

- See Figure 3-2 for the location of gas inlets and

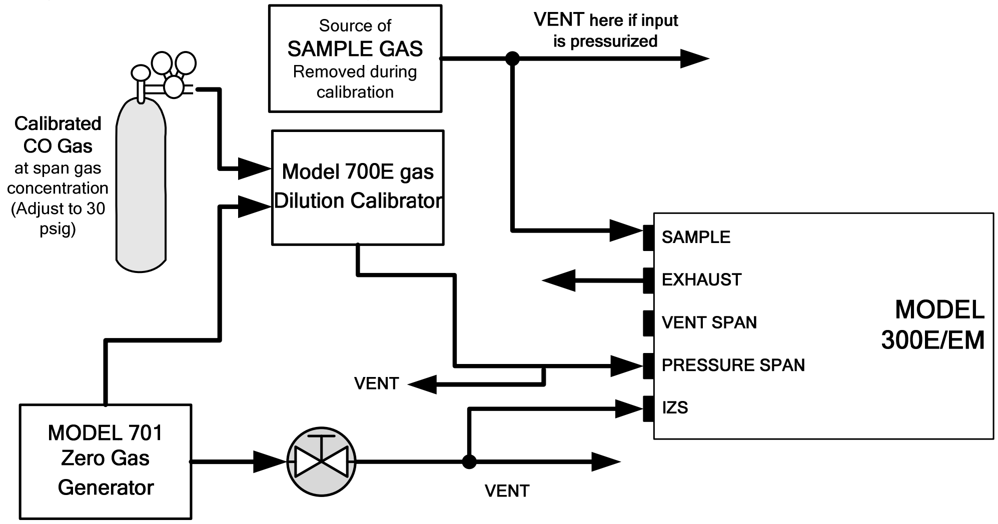

Figure 5-4: Pneumatic Connections – Option 50A: Zero/Span Calibration Valves

SAMPLE GAS SOURCE:

Attach a sample inlet line to the sample inlet port. The SAMPLE input line should not be more than 2 meters long.

- Maximum pressure of any gas at the sample inlet should not exceed 1.5 in-hg above ambient pressure and ideally should equal ambient atmospheric pressure.
- In applications where the sample gas is received from a pressurized manifold, a vent must be placed on the sample gas before it enters the analyzer.

CALIBRATION GAS SOURCES:

A vent is required when an M700 is used with this option. However, if an M700E is used, a vent may or may not be required depending on how the M700E output manifold is configured.

SPAN GAS:

- Attach a gas line from the source of calibration gas (e.g. a Teledyne API's M700E Dynamic Dilution Calibrator) to the **SPAN** inlet at 30 psig.

ZERO AIR:

- Zero air is supplied via a zero air generator such as a Teledyne API's M701.
- An adjustable valve is installed in the zero air supply line to regulate the gas flow.

5.6.2.3. **Input Gas Venting**

The zero air supply and sample gas line MUST be vented in order to ensure that the gases input do not exceed the maximum inlet pressure of the analyzer as well as to prevent back diffusion and pressure effects. These vents should be:

- At least 0.2m long;
- No more than 2m long and;
- Vented outside the shelter or immediate area surrounding the instrument.

5.6.2.4. **Exhaust Outlet**

Attach an exhaust line to the analyzer's EXHAUST outlet fitting. The exhaust line should be:

- PTEF tubing; minimum O.D ¼";
- A maximum of 10 meters long;
- Vented outside the analyzer's enclosure.

5.6.3. **ZERO/SPAN/SHUTOFF VALVE (OPTION 50B)**

This option requires that both zero air and span gas be supplied from external sources.

- Span gas will be supplied from a pressurized bottle of calibrated CO gas.
  - A critical flow control orifice, internal to the instrument ensures that the proper flow rate is maintained.
  - An internal vent line ensures that the gas pressure of the span gas is reduced to ambient atmospheric pressure.
  - A SHUTOFF valve preserves the span gas source when it is not in use.
- Zero gas is supplied by either an external scrubber or a zero air generator such as the Teledyne API's M701.

5.6.3.1. **Internal Pneumatics (OPT 50B)**

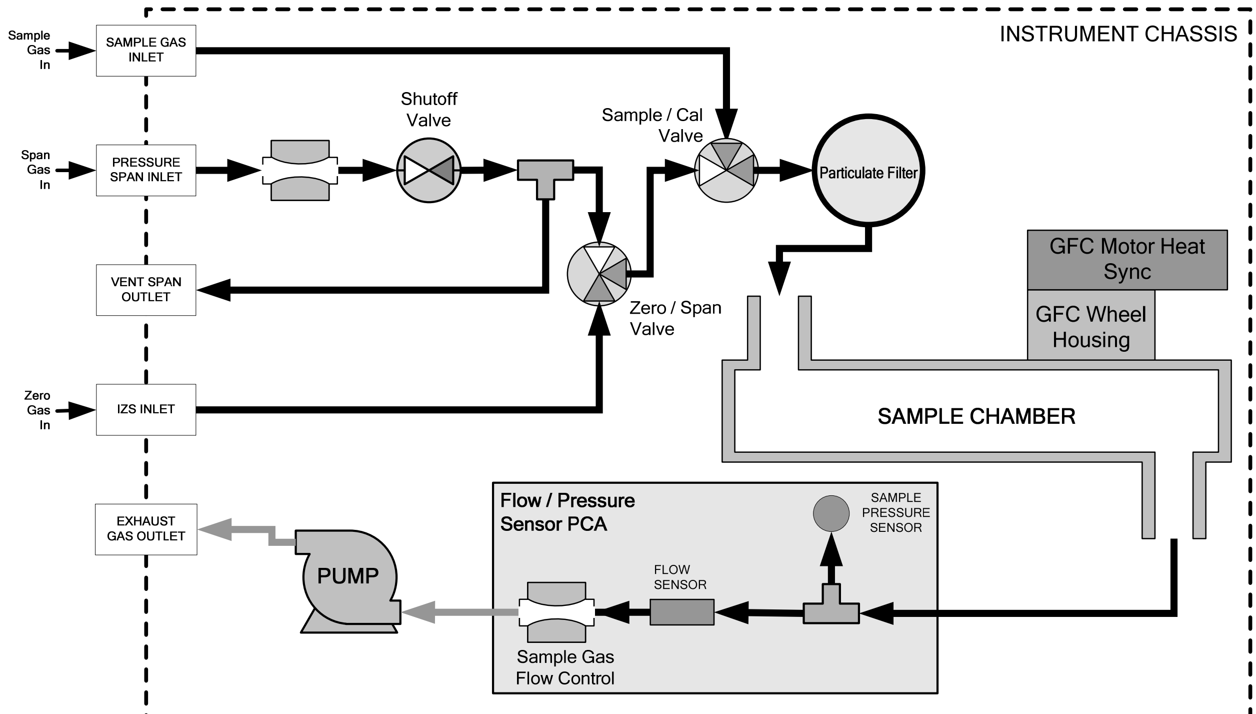

Figure 5-5: Internal Pneumatic Flow OPT 50B – Zero/Span/Shutoff Valves

Table 5-2: Zero/Span Valve Operating States for Option 50B

MODE	VALVE	CONDITION
SAMPLE (Normal State)	Sample/Cal	Open to SAMPLE inlet
	Zero/Span	Open to IZS inlet
	Shutoff Valve	Closed
ZERO CAL	Sample/Cal	Open to ZERO/SPAN valve
	Zero/Span	Open to IZS inlet
	Shutoff Valve	Closed
SPAN CAL	Sample/Cal	Open to ZERO/SPAN valve
	Zero/Span	Open to SHUTOFF valve
	Shutoff Valve	Open to PRESSURE SPAN Inlet

5.6.3.2. Pneumatic Set Up (OPT 50B)

See Figure 3-2 for the location of gas inlets and outlets.

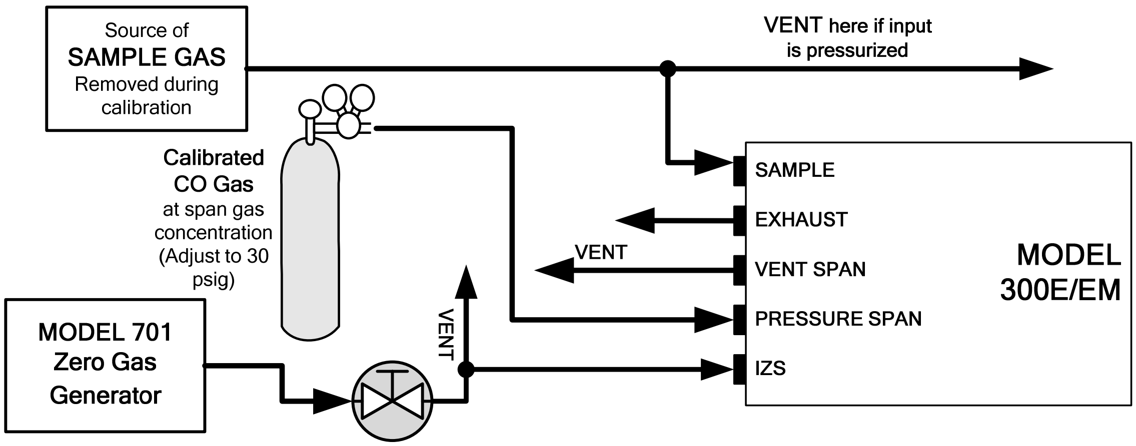

Figure 5-6: Pneumatic Connections – Option 50B: Zero/Pressurized Span Calibration Valves

SAMPLE GAS SOURCE:

Attach a sample inlet line to the sample inlet port. The SAMPLE input line should not be more than 2 meters long.

- Maximum pressure of any gas at the sample inlet should not exceed 1.5 in-hg above ambient pressure and ideally should equal ambient atmospheric pressure.
- In applications where the sample gas is received from a pressurized manifold, a vent must be placed on the sample gas before it enters the analyzer.

CALIBRATION GAS SOURCES:

SPAN GAS:

- Attach a gas line from the pressurized source of calibration gas (e.g. a bottle of NIST-SRM gas) to the SPAN inlet at 30 psig.

ZERO AIR:

- Zero air is supplied via a zero air generator such as a Teledyne API's M701.
- An adjustable valve is installed in the zero air supply line to regulate the gas flow.

INPUT GAS VENTING:

The zero air supply and sample gas line MUST be vented in order to ensure that the gases input do not exceed the maximum inlet pressure of the analyzer as well as to prevent back diffusion and pressure effects. These vents should be:

- At least 0.2m long;
- No more than 2m long and;
- Vented outside the shelter or immediate area surrounding the instrument.

A similar vent line should be connected to the VENT SPAN outlet on the back of the analyzer.

EXHAUST OUTLET

Attach an exhaust line to the analyzer's EXHAUST outlet fitting. The exhaust line should be:

- PTEF tubing; minimum O.D ¼";
- A maximum of 10 meters long;
- Vented outside the analyzer's enclosure.

5.6.4. ZERO/SPAN VALVE WITH INTERNAL CO SCRUBBER (OPTION 50H)

Option 50H is operationally and pneumatically similar to Option 50A above, except that the zero air is generated by an internal zero air scrubber. This means that the IZS inlet can simply be left open to ambient air.

Internal zero/span and sample/cal valves control the flow of gas through the instrument, but because the generator and calibrator limit the flow of zero air and span gas no shutoff valves are required.

5.6.4.1. Internal Pneumatics (OPT 50H)

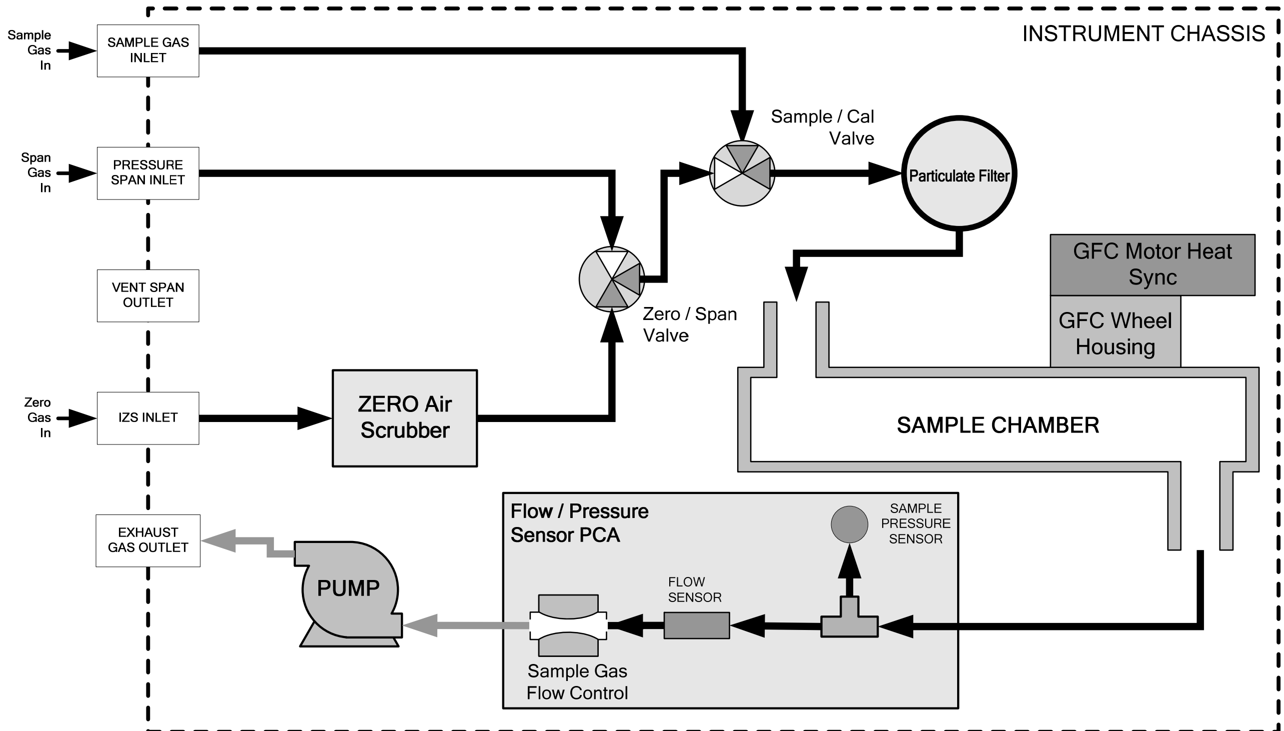

Figure 5-7: Internal Pneumatic Flow OPT 50H – Zero/Span Valves with Internal Zero Air Scrubber

Table 5-3: Zero/Span Valve Operating States for Option 50H

MODE	VALVE	CONDITION
SAMPLE (Normal State)	Sample/Cal	Open to SAMPLE inlet
	Zero/Span	Open to ZERO AIR scrubber
ZERO CAL	Sample/Cal	Open to ZERO/SPAN valve
	Zero/Span	Open to ZERO AIR scrubber
SPAN CAL	Sample/Cal	Open to ZERO/SPAN valve
	Zero/Span	Open to PRESSURE SPAN inlet

5.6.4.2. **Pneumatic Set Up (OPT 50H)**

See Figure 3-2 for the location of gas inlets and outlets and span gas no shutoff valves are required.

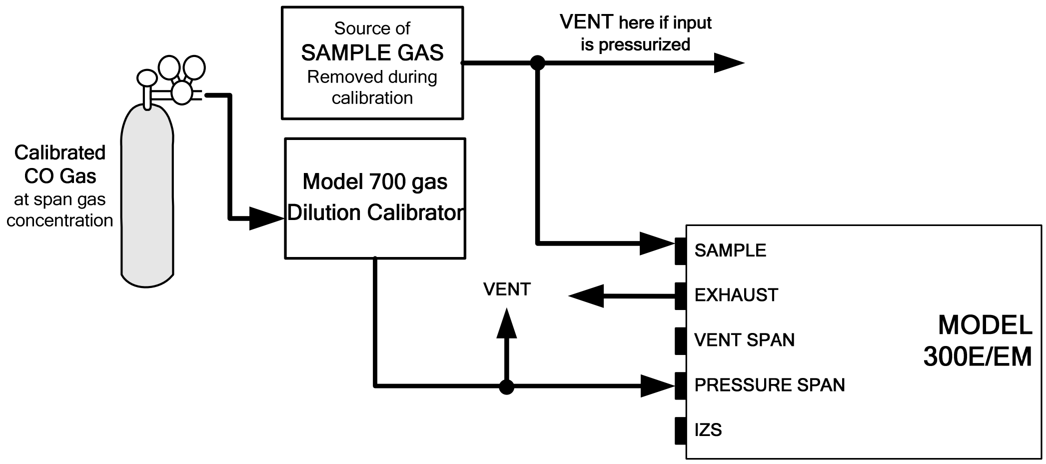

Figure 5-8: Pneumatic Connections – Option 50H: Zero/Span Calibration Valves

SAMPLE GAS SOURCE:

Attach a sample inlet line to the sample inlet port. The SAMPLE input line should not be more than 2 meters long.

- Maximum pressure of any gas at the sample inlet should not exceed 1.5 in-Hg above ambient pressure and ideally should equal ambient atmospheric pressure.
- In applications where the sample gas is received from a pressurized manifold, a vent must be placed on the sample gas before it enters the analyzer.

CALIBRATION GAS SOURCES:

SPAN GAS:

- Attach a gas line from the source of calibration gas (e.g. a Teledyne API's M700E Dynamic Dilution Calibrator) to the **SPAN** inlet.

ZERO AIR:

- Zero air is supplied internally via a zero air scrubber that draws ambient air through the IZS inlet.

INPUT GAS VENTING:

The zero air supply and sample gas line MUST be vented in order to ensure that the gases input do not exceed the maximum inlet pressure of the analyzer as well as to prevent back diffusion and pressure effects. These vents should be:

- At least 0.2m long;
- No more than 2m long and;
- Vented outside the shelter or immediate area surrounding the instrument.

EXHAUST OUITLET

Attach an exhaust line to the analyzer's EXHAUST outlet fitting. The exhaust line should be:

- PTEF tubing; minimum O.D ¼";
- A maximum of 10 meters long;
- Vented outside the analyzer's enclosure.

5.6.5. ZERO/SPAN/SHUTOFF WITH INTERNAL ZERO AIR SCRUBBER (OPTION 50E)

5.6.5.1. Internal Pneumatics (OPT 50E)

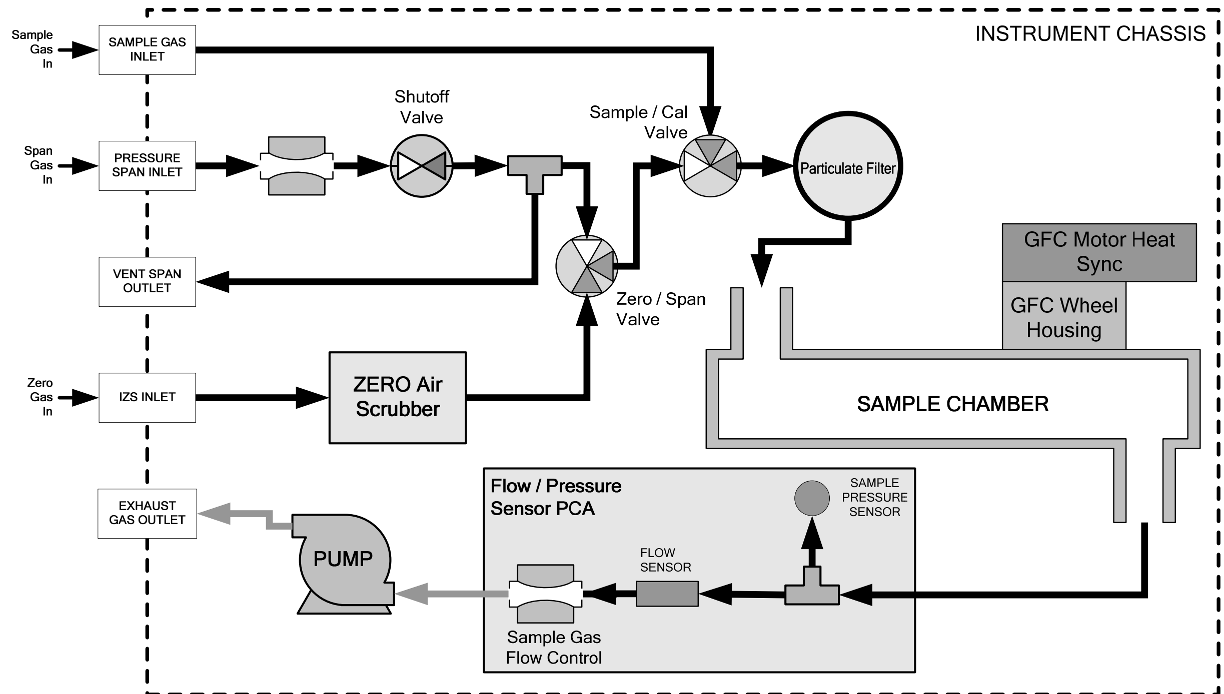

Figure 5-9: Internal Pneumatic Flow OPT 50E – Zero/Span/Shutoff Valves with Internal Zero Air Scrubber

Table 5-4: Zero/Span Valve Operating States for Option 50E

Mode	Valve	Condition
SAMPLE (Normal State)	Sample/Cal	Open to SAMPLE inlet
	Zero/Span	Open to internal ZERO AIR scrubber
	Shutoff Valve	Closed
ZERO CAL	Sample/Cal	Open to zero/span valve
	Zero/Span	Open to internal ZERO AIR scrubber
	Shutoff Valve	Closed
SPAN CAL	Sample/Cal	Open to ZERO/SPAN valve
	Zero/Span	Open to SHUTOFF valve
	Shutoff Valve	Open to PRESSURE SPAN inlet

5.6.5.2. **Pneumatic Set Up (OPT 50E)**

See Figure 3-2 for the location of gas inlets and outlets.

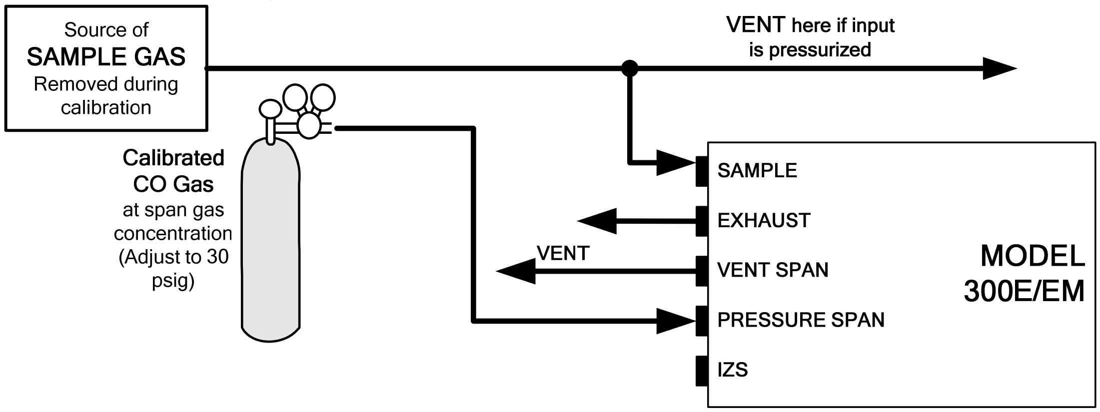

Figure 5-10: Pneumatic Connections – Option 50E: Zero/Span Calibration Valves

SAMPLE GAS SOURCE:

Attach a sample inlet line to the sample inlet port. The SAMPLE input line should not be more than 2 meters long.

- Maximum pressure of any gas at the sample inlet should not exceed 1.5 in-hg above ambient pressure and ideally should equal ambient atmospheric pressure.
- In applications where the sample gas is received from a pressurized manifold, a vent must be placed on the sample gas before it enters the analyzer.

CALIBRATION GAS SOURCES:

SPAN GAS:

- Attach a gas line from the pressurized source of calibration gas (e.g. a bottle of NIST-SRM gas) to the span inlet.
- Span gas can by generated by a M700E Dynamic Dilution Calibrator.

ZERO AIR:

- Zero air is supplied internally via a zero air scrubber that draws ambient air through the IZS inlet.

INPUT GAS VENTING:

The zero air supply and sample gas line MUST be vented in order to ensure that the gases input do not exceed the maximum inlet pressure of the analyzer as well as to prevent back diffusion and pressure effects. These vents should be:

- At least 0.2m long;
- No more than 2m long and;
- Vented outside the shelter or immediate area surrounding the instrument.

A similar vent line should be connected to the VENT SPAN outlet on the back of the analyzer.

EXHAUST OUITLET

Attach an exhaust line to the analyzer's EXHAUST outlet fitting. The exhaust line should be:

- PTEF tubing; minimum O.D ¼";
- A maximum of 10 meters long;
- Vented outside the analyzer's enclosure.

5.7. COMMUNICATION OPTIONS

5.7.1. RS-232 MODEM CABLE (OPTION 60A)

Table 5-5: M300E/EM Modem Cable Options

OPTION NO.	DESCRIPTION
60A	Shielded, straight-through DB-9F to DB-25M cable of about 1.8 m length. • This cable is used to interface with older computers or code activated switches with a DB-25 serial connectors.
60B	Shielded, straight-through DB-9F to DB-9F cable of about 1.8 m length, which should fit most computers of recent build.
60C	CAT5 7' cable, a shielded straight through cable, 2 meters in length, terminated with RJ45 connectors. • For use with the M300E/EM Analyzer's optional Ethernet Card (Option 63A).

5.7.2. RS-232 MULTIDROP (OPTION 62)

The multidrop option is used with RS232 and utilizes both DB-9 connectors on the rear panel to enable communications of up to eight analyzers with the host computer over a chain of RS-232 cables. It is subject to the distance limitations of the RS-232 standard.

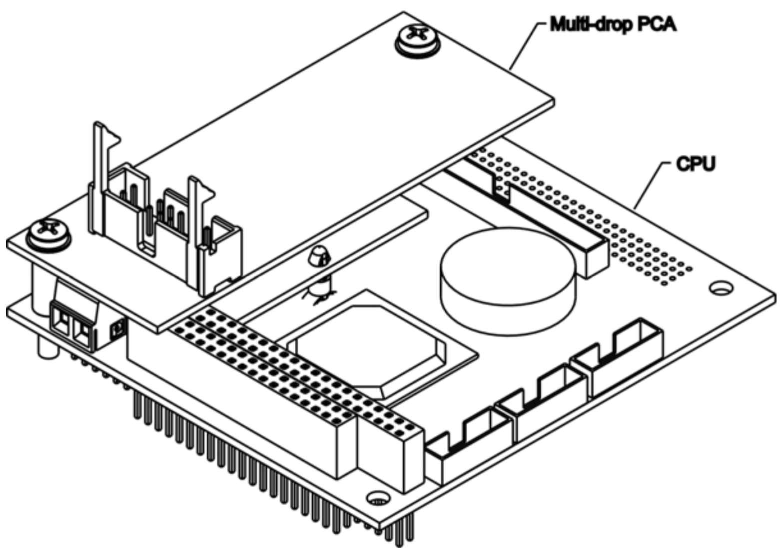

Figure 5-11: M300E/EM Multidrop Card Seated on CPU above Disk on Module

The option consists of a small printed circuit assembly, which plugs into to the analyzer's CPU card and is connected to the RS-232 and COM2 DB9 connectors on the instrument's back panel via a cable to the motherboard.

- One OPT 62 and one OPT 60B are required for each analyzer along the multidrop network. See Section 8.2 for information regarding setting up a multidrop network for M300E/EM Analyzers.

5.7.3. **ETHERNET (OPTION 63A)**

The ETHERNET option allows the analyzer to be connected to any Ethernet Local Area Network (LAN) running TCP/IP. The local area network must have routers capable of operating at 10BaseT. If internet access is available through the LAN, this option also allows communication with the instrument over the public internet. Maximum communication speed is limited by the RS-232 port to 115.2 kBaud.

When installed, this option is electronically connected to the instrument's COM2 serial port making that port no longer available for RS-232/RS-485 communications.

The option consists of a Teledyne API's designed Ethernet card (see Figure 5-12 and Figure 5-13), and a 7-foot long CAT-5 network cable, terminated at both ends with standard RJ-45 connectors.

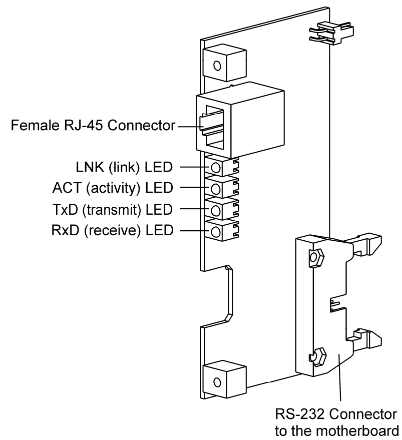

Figure 5-12: M300E/EM Ethernet Card

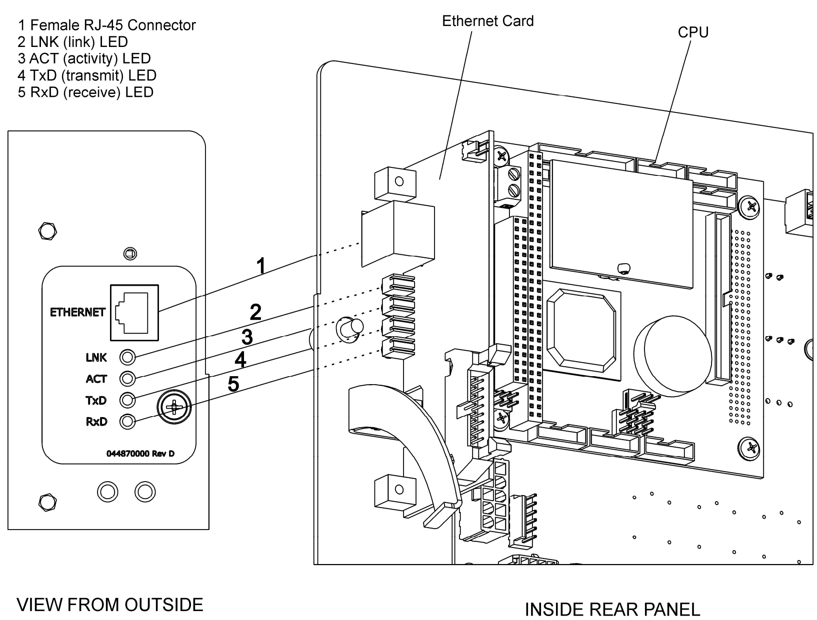

Figure 5-13: M300E/EM Rear Panel with Ethernet Installed

For more information on setting up and using this option, see Section 8.4.

5.7.4. ETHERNET + MULTIDROP (OPT 63C)

This option allows the instrument to communicate on both RS-232 and ETHERNET networks simultaneously. It includes the following:

- RS-232 MULTIDROP (OPT 62)
- ETHERNET (OPT 63A)

5.8. SECOND GAS SENSORS

5.8.1. OXYGEN SENSOR (OPTION 65A)

5.8.1.1. Theory of Operation - Paramagnetic measurement of O_2

The oxygen sensor used in the M300E/EM Analyzer utilizes the fact that oxygen is attracted into strong magnetic field while most other gases are not, to obtain fast, accurate oxygen measurements.

The sensor's core is made up of two nitrogen filled glass spheres, which are mounted on a rotating suspension within a magnetic field (see Figure 5-14). A mirror is mounted centrally on the suspension and light is shone onto the mirror that reflects the light onto a pair of photocells. The signal generated by the photocells is passed to a feedback loop, which outputs a current to a wire winding (in effect, a small DC electric motor) mounted on the suspended mirror.

Oxygen from the sample stream is attracted into the magnetic field displacing the nitrogen filled spheres and causing the suspended mirror to rotate. This changes the amount of light reflected onto the photocells and therefore the output levels of the photocells. The feedback loop increases the amount of current fed into the winding in order to move the mirror back into its original position. The more O_2 present, the more the mirror moves and the more current is fed into the winding by the feedback control loop.

A sensor measures the amount of current generated by the feedback control loop which is directly proportional to the concentration of oxygen within the sample gas mixture.

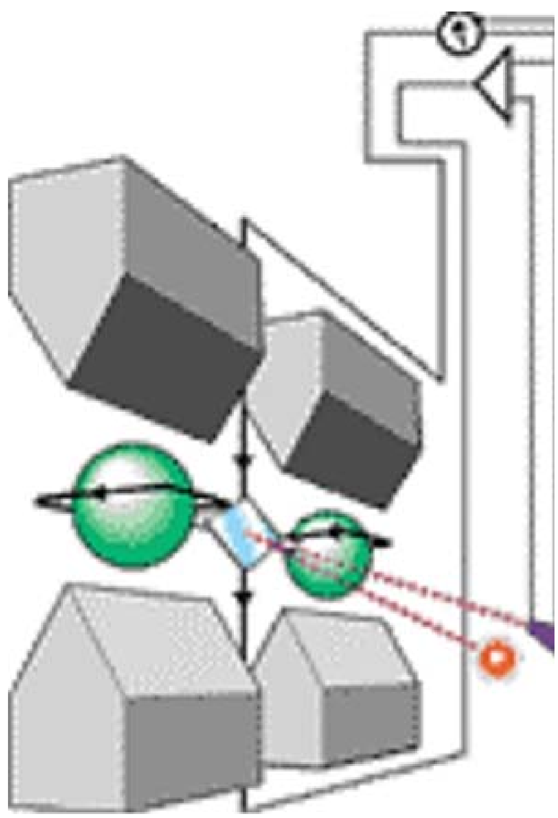

Figure 5-14: Oxygen Sensor - Principle of Operation

5.8.1.2. **Operation within the M300E/EM Analyzer**

The oxygen sensor option is transparently integrated into the core analyzer operation. All functions can be viewed or accessed through the front panel, just like the functions for CO.

- The O_2 concentration is displayed in the upper right-hand corner, alternating with CO concentration.
- Test functions for O_2 slope and offset are viewable from the front panel along with the analyzer's other test functions.
- O_2 sensor calibration is performed via the front panel **CAL** function and is performed in a nearly identical manner as the standard CO calibration. See Section 9.7.1 for more details.
- Stability of the O_2 sensor can be viewed via the front panel (see Section 9.7.1.3).

The O_2 concentration range is 0-100% (user selectable) with 0.1% precision and accuracy.

The temperature of the O_2 sensor is maintained at a constant 50° C by means of a PID loop and can be viewed on the front panel as test function O_2 TEMP.

The O_2 sensor assembly itself does not have any serviceable parts and is enclosed in an insulated canister.

5.8.1.3. **Pneumatic Operation of the O_2 Sensor**

- Pneumatically, the O_2 sensor draws a flow of 80 cm³/min in addition to the normal sample flow rate. It is separately controlled with its own critical flow orifice.

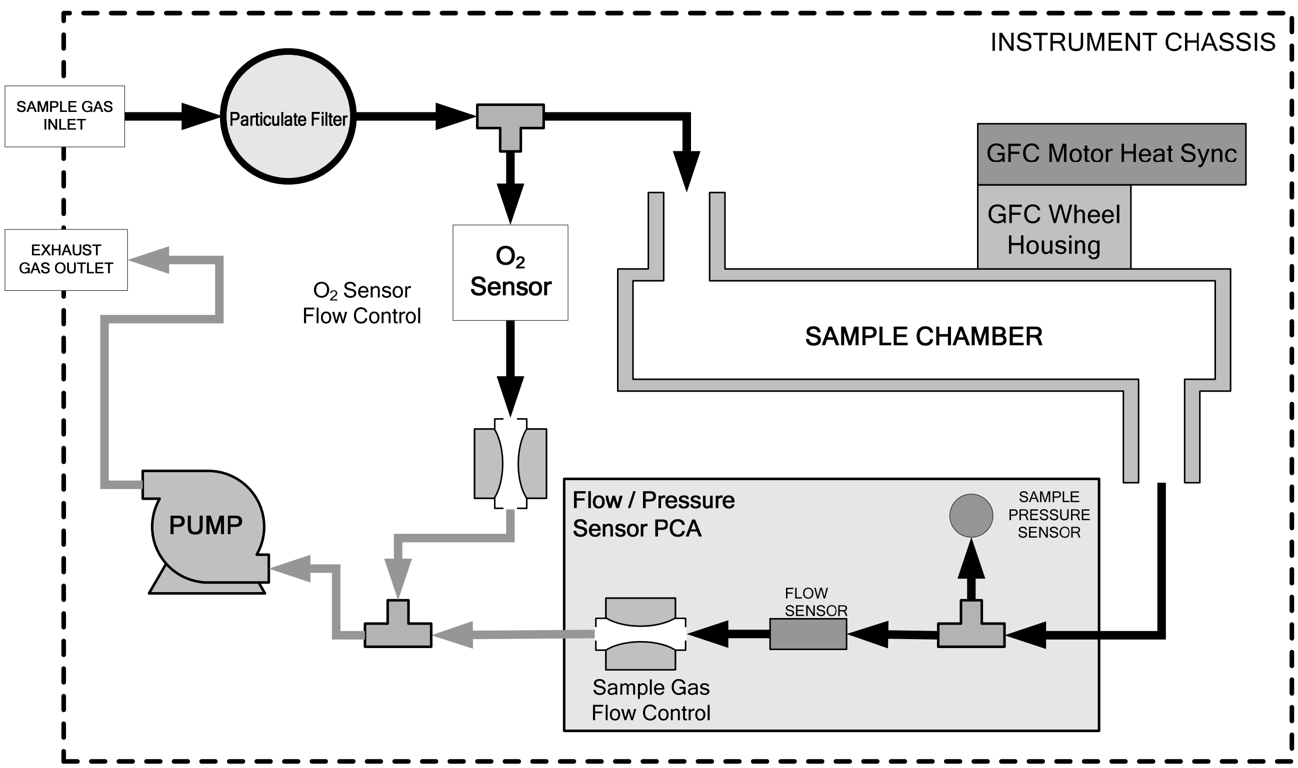

Figure 5-15: M300E/EM – Internal Pneumatics with O_2 Sensor Option 65A

5.9. **CARBON DIOXIDE SENSOR (OPTION 67A)**

The optional CO_2 sensor allows the M300E/EM to measure both CO and CO_2 simultaneously. This option includes a CO_2 sensor probe, a Logic PCA that conditions the probe output and issues a 0-5 VDC signal to the analyzer's CPU that is used to compute the CO_2 concentration.

The M300E/EM receives this input, scales it based on the values of the CO_2**_SLOPE** and CO_2**_OFFSET** recorded during calibration (see Section 9.7.2).

Figure 3-4 shows the location of the Sensor Probe and PCA within the M300E/EM.

The CO_2 sensor assembly itself does not have any serviceable parts and is enclosed in an insulated canister.

5.9.1. **CO_2 SENSOR RANGES AND SPECIFICATIONS**

Table 5-6: CO_2 Sensor - Available Ranges

OPTION NO.	RANGES	ANALYZER MODEL(S)
67A	0-20%	M300EM

Table 5-7: CO_2 Sensor Specifications

Accuracy at 25˚C	0.02% CO + 2% of reading
Linearity	0.5 % of full scale
Typical Temperature Dependence	-0.1% FS / ˚C
Long Term Stability	<+15 % FS / 2 years
Response time	20 seconds
Warm up time	5 minutes
Power consumption	2.5 watts

5.9.2. **THEORY OF OPERATION**

5.9.2.1. **NDIR measurement of CO_2**

The optional CO_2 sensor is a silicon based Non-Dispersive Infrared (NDIR) sensor. It uses a single-beam, dual wavelength measurement method.

An infrared source at one end of the measurement chamber emits IR radiation into the sensor's measurement chamber where light at the 4.7 µm wavelength is partially absorbed by any CO_2 present. A special light filter called a Fabry-Perot Interferometer (FPI) is electronically tuned so that only light at the absorption wavelength of CO_2 is allowed to pass and be detected by the sensor's IR detector.

A reference measurement is made by electronically shifting the filter band pass wavelength so that no IR at the CO_2 absorption wavelength is let through.

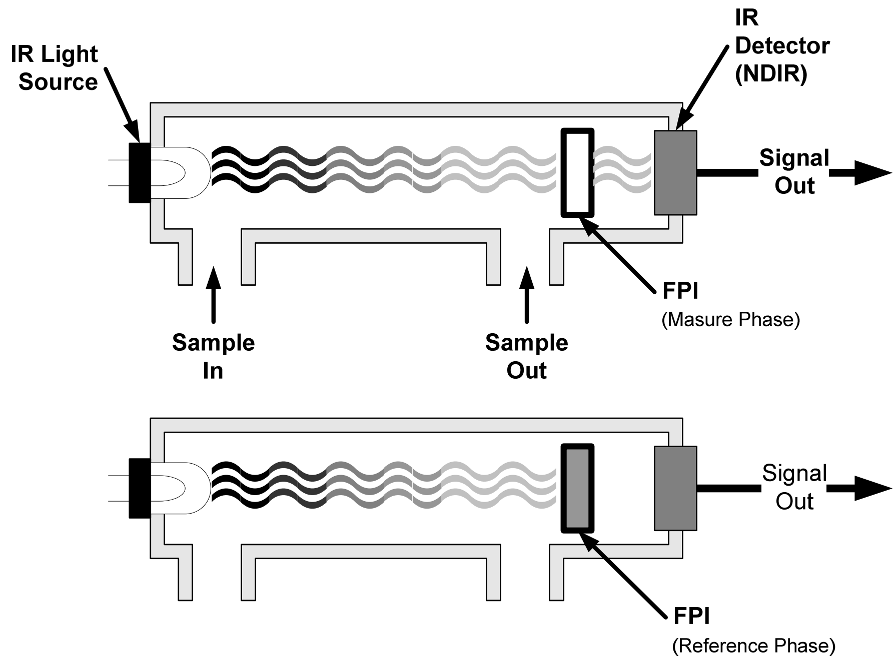

Figure 5-16: CO_2 sensor Theory of Operation

The sensor computes the ratio between the reference signal and the measurement signal to determine the degree of light absorbed by CO_2 present in the sensor chamber. This dual wavelength method the CO_2 measurement allows the instrument to compensate for ancillary effects like sensor aging and contamination.

5.9.2.2. **Operation within the M300E/EM Analyzer**

The CO_2 sensor option is transparently integrated into the core analyzer operation. All functions can be viewed or accessed through the front panel, just like the functions for CO.

- The CO_2 concentration is displayed in the upper right-hand corner, alternating with CO concentration.
- Test functions for CO_2 slope and offset are viewable from the front panel along with the analyzer's other test functions.
- CO_2 sensor calibration is performed via the front panel **CAL** function and is performed in a nearly identical manner as the standard CO calibration. See Section 9.7.2 for more details.
- Stability of the CO_2 sensor can be viewed via the front panel (see Section 9.7.2.3).

The CO_2 concentration range is 0-20%. See Section 9.7.2.1 for information on calibrating the CO_2.

5.9.2.3. **Pneumatic Operation of the CO_2 Sensor**

Pneumatically, the CO_2 sensor is placed in line with the sample gas line between the particulate filter and the analyzer's sample chamber. It does not alter the gas flow rate of the sample through the analyzer.

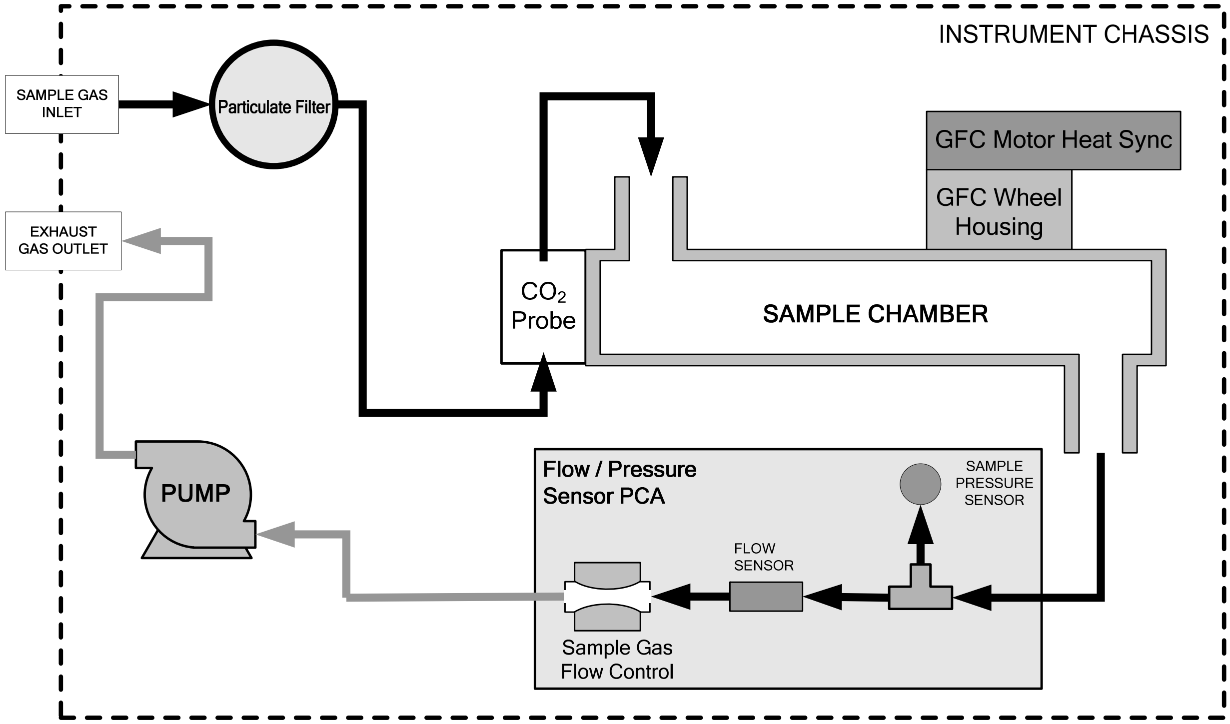

Figure 5-17: M300E/EM – Internal Pneumatics with CO_2 Sensor Option 66

5.9.2.4. Electronic Operation of the CO_2 Sensor

The CO_2 PCA which is mounted to the rear side of the Relay Board Mounting Bracket controls the CO_2 Sensor. It converts the sensor's digital output to an analog voltage that is measured with the motherboard and draws 12 VDC from the analyzer via the relay card from which converts to fit the power needs of the probe and its own onboard logic. It outputs a 0-5 VDC analog signal to the analyzer's CPU via the motherboard that corresponds to the concentration of CO_2 measured by the probe.

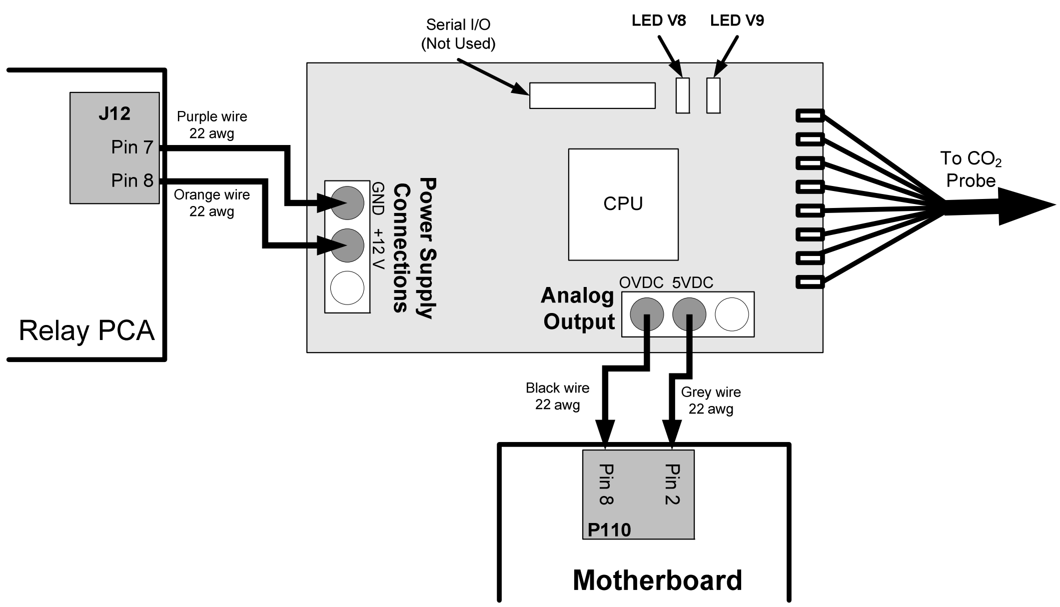

Figure 5-18: CO_2 Sensor Option PCA Layout and Electronic Connections

5.10. **CONCENTRATION ALARM RELAY (OPTION 61)**

The Teledyne API “E” series analyzers have an option for four (4) “dry contact” relays on the rear panel of the instrument. This relay option is different from and in addition to the “Contact Closures” that come standard on all TAPI instruments. The relays have 3 pins that have connections on the rear panel (see Figure 5-19). They are a Common (C), a Normally Open (NO), & a Normally Closed (NC) pin.

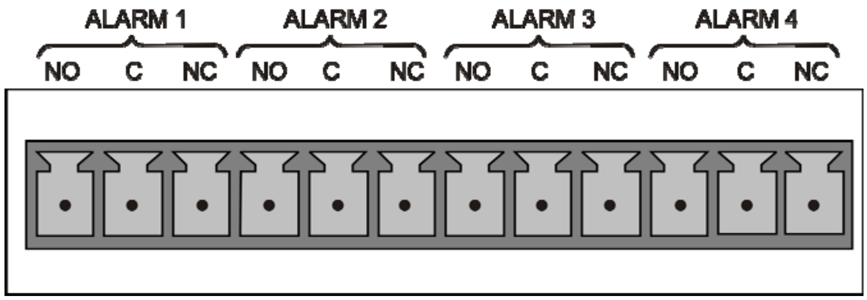

Figure 5-19: Concentration Alarm Relay

Alarm 1	“System OK 2”
Alarm 2	“Conc 1”
Alarm 3	“Conc 2”
Alarm 4	“Range Bit”

“Alarm 1” Relay

Alarm 1 which is “System OK 2” (system OK 1, is the status bit) is in the energized state when the instrument is “OK” & there are no warnings. If there is a warning active or if the instrument is put into the “DIAG” mode, Alarm 1 will change states. This alarm has “reverse logic” meaning that if you put a meter across the Common & Normally Closed pins on the connector you will find that it is OPEN when the instrument is OK. This is so that if the instrument should turn off or loose power, it will change states & you can record this with a data logger or other recording device.

“Alarm 2” Relay & “Alarm 3” Relay

The “Alarm 2 Relay” on the rear panel, is associated with the “Concentration Alarm 1” set point in the software & the “Alarm 3 Relay” on the rear panel is associated with the “Concentration Alarm 2” set point in the software.

Alarm 2 Relay	CO Alarm 1 = xxx PPM
Alarm 3 Relay	CO_2 Alarm 2 = xxx PPM
Alarm 2 Relay	CO Alarm 1 = xxx PPM
Alarm 3 Relay	CO_2 Alarm 2 = xxx PPM

The Alarm 2 Relay will be turned on any time the concentration set-point is exceeded & will return to its normal state when the concentration value goes back below the concentration set-point.

Even though the relay on the rear panel is a NON-Latching alarm & resets when the concentration goes back below the alarm set point, the warning on the front panel of the instrument will remain latched until it is cleared. You can clear the warning on the front panel by either pushing the CLR button on the front panel or through the serial port.

In instruments that sample more than one gas type, there could be more than one gas type triggering the Concentration 1 Alarm (“Alarm 2” Relay). For example, the M300EM instrument can monitor both CO & CO_2

gas. The software is flexible enough to allow you to configure the alarms so that you can have 2 alarm levels for each gas.

CO Alarm 1 = 20 PPM
CO Alarm 2 = 100 PPM
CO_2 Alarm 1 = 20 PPM
CO_2 Alarm 2 = 100 PPM

In this example, CO Alarm 1 & CO_2 Alarm 1 will both be associated with the “Alarm 2” relay on the rear panel. This allows you do have multiple alarm levels for individual gasses.
A more likely configuration for this would be to put one gas on the “Alarm 1” relay & the other gas on the “Alarm 2” relay.

CO Alarm 1 = 20 PPM
CO Alarm 2 = Disabled
CO_2 Alarm 1 = Disabled
CO_2 Alarm 2 = 100 PPM
“Alarm 4” Relay
This relay is connected to the “range bit”. If the instrument is configured for “Auto Range” & the instrument goes up into the high range, it will turn this relay on.

5.11. SPECIAL FEATURES

5.11.1. DILUTION RATIO OPTION

The Dilution Ratio Option is a software option that is designed for applications where the Sample gas is diluted before being analyzed by the M300E. Typically this occurs in Continuous Emission Monitoring (CEM) applications where the quality of gas in a smoke stack is being tested and the sampling method used to remove the gas from the stack dilutes the gas.

Once the degree of dilution is known, this feature allows the user to add an appropriate scaling factor to the analyzer's CO concentration calculation so that the Measurement Range and concentration values displayed on the instrument's Front Panel Display and reported via the Analog and Serial Outputs reflect the undiluted values.

Instructions for using the dilution ratio option can be found in Section 6.6.5.

5.11.2. MAINTENANCE MODE SWITCH

API's instruments can be equipped with a switch that places the instrument in maintenance mode. When present, the switch is accessed by opening the hinged front panel and is located on the rearward facing side of the display/keyboard driver PCA, on the left side, near the particulate filter.

When in maintenance mode the instrument ignores all commands received via the **COMM** ports that alter the operation state of the instrument. This includes all calibration commands, diagnostic menu commands and the reset instrument command. The instrument continues to measure concentration and send data when requested.

This option is of particular use for instruments connected to multidrop or Hessen protocol networks.

5.11.3. SECOND LANGUAGE SWITCH

API's instruments can be equipped with a switch that activates an alternate set of display message in a language other than the instrument's default language. To activate this feature, the instrument must have a specially programmed Disk-on-Module (DOM) containing the second language. Call Customer Service for this DOM.

PART II
–
OPERATING INSTRUCTIONS

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6. BASIC OPERATION

The M300E/EM Analyzer is a computer-controlled analyzer with a dynamic menu interface that allows all major operations to be controlled from the front panel display and keyboard through user-friendly menus (a complete set of menu trees is located in Appendix A of this manual).

This section includes step-by-step instructions for using the display/keyboard to set up and operate the M300E/EM Analyzer's basic CO measurement features and functional modes.

6.1. OVERVIEW OF OPERATING MODES

The M300E/EM software has a variety of operating modes. Most commonly, the analyzer will be operating in **Sample Mode**. In this mode a continuous read-out of the CO concentration is displayed on the front panel. If the analyzer is configured to measure more than one gas (e.g. CO along with O_2 or CO_2) the display will cycle through gas list.

While in **SAMPLE** mode calibrations can be performed and **TEST** functions as well as WARNING messages can be examined. If any of the analyzer’s analog outputs are enabled, the current concentration value will be available at the analog output connector.

The second most important operating mode is **SETUP** mode. This mode is used for performing certain configuration operations, such as programming the iDAS system or the configurable analog output channels, or setting up the analyzer’s serial communication channels (RS-232/RS-485/Ethernet). The **SETUP** mode is also used for performing various diagnostic tests during troubleshooting.

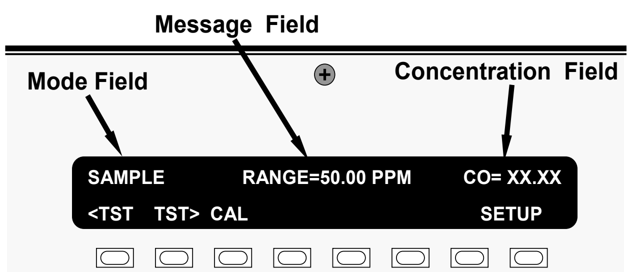


Figure 6-1: Front Panel Display

The mode field of the front panel display indicates to the user which operating mode the unit is currently running.

Besides **SAMPLE** and **SETUP**, other modes the analyzer can be operated in are:

Table 6-1: Analyzer Operating Modes

MODE	EXPLANATION
SAMPLE	Sampling normally, flashing text indicates adaptive filter is on.
SAMPLE A	Indicates that unit is in **Sample Mode** while **AUTOCAL** feature is active (Internal Span Only).
M-P CAL	This is the basic calibration mode of the instrument and is activated by pressing the CAL key.
SETUP *[X.X]*	**SETUP** mode is being used to configure the analyzer. The gas measurement will continue during this process. The revision of the M300E/EM firmware being run will appear after the word “**SETUP**”
ZERO CAL *[type]* [1,2 & 3]	Unit is performing **ZERO** calibration procedure.
LO CAL *[type]* [2 & 3]	Unit is performing **LOW SPAN** (midpoint) cal check procedure.
SPAN CAL *[type]* [1,2 & 3]	Unit is performing **SPAN** calibration procedure.
DIAG Mode	One of the analyzer’s diagnostic modes is active (Section 7.3).
[type:] [1]A: Initiated automatically by the **AUTOCAL** feature (Internal Span Only). [2]M: initiated manually by the user via the front panel controls. [3]R: initiated remotely through the COM ports or digital control inputs.	

6.2. SAMPLE MODE

This is the analyzer's standard operating mode. In this mode the instrument is analyzing the gas in the sample chamber, calculating CO concentration and reporting this information to the user via the front panel display, the analog outputs and, if set up properly, the RS-232/RS-485/Ethernet ports.

> **NOTE**
>
> **A value of "XXXX" displayed in the CO Concentration field means that the M/R ratio is invalid because CO REF is either too high (> 4950 mVDC) or too low (< 1250 VDC).**
>
> **A value of "XXXX" displayed for any of the TEST functions indicates an out-of-range reading or the analyzer's inability to calculate it.**

A variety of **TEST** functions are available for viewing at the front panel whenever the analyzer is at the **MAIN MENU**. These functions provide information about the various functional parameters related to the analyzers operation and its measurement of gas concentrations. This information is particularly a performance problem during troubleshooting (see Section 13.1.2).

To view these **TEST** functions, press,

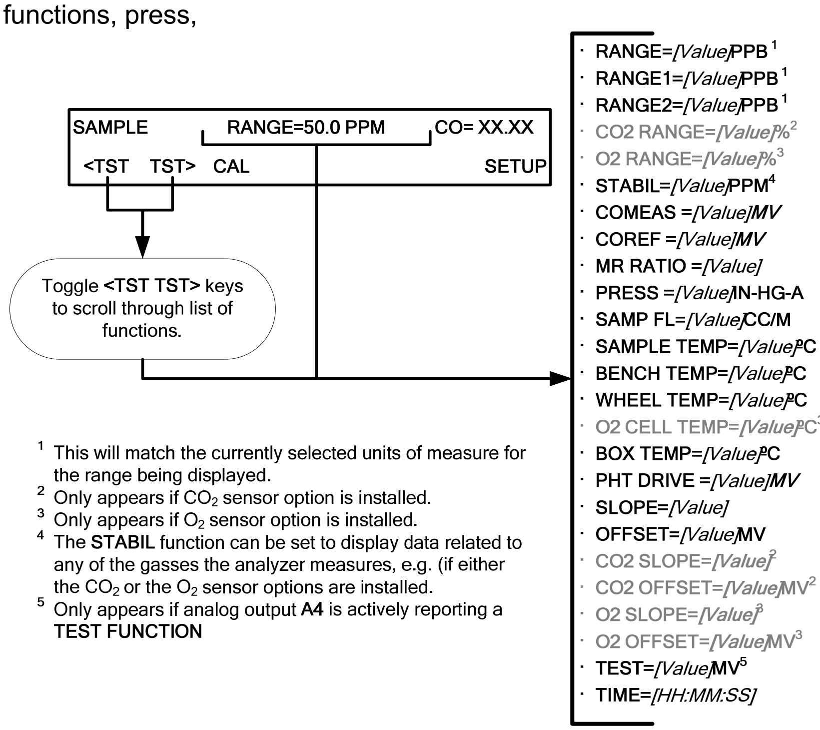


Figure 6-2: Viewing M300E/EM Test Functions

> **NOTE**
>
> **All pressure measurements are represented in terms of absolute pressure. Absolute, atmospheric pressure is 29.92 in-Hg-A at sea level. It decreases about 1 in-Hg per 300 m gain in altitude. A variety of factors such as air conditioning and passing storms can cause changes in the absolute atmospheric pressure.**

Table 6-2: Test Functions Defined

PARAMETER	DISPLAY TITLE	UNITS	MEANING
Stability	**STABIL**	PPB[3], PPM UGM[3], MGM	Standard deviation of CO concentration readings. Data points are recorded every ten seconds using the last 25 data points. This function can be reset to show O_2 or CO_2 stability in instruments with those sensor options installed.
Range	**RANGE** **RANGE1**[1] **RANGE2**[1]	PPB, PPM, UGM, MGM	The full scale limit at which the reporting range of the analyzer is currently set. THIS IS NOT the Physical Range of the instrument. See Section 6.6.1 for more information.
O_2 Range [1]	O_2 **RANGE**	%	The range setting for the optional O_2 Sensor.
CO_2 Range[2]	CO_2 **RANGE**	%	The range setting for the optional CO_2 Sensor.
CO Measure	**CO MEAS**	MV	The demodulated, peak IR detector output during the measure portion of the GFC Wheel cycle.
CO Reference	**CO REF**	MV	The demodulated, peak IR detector output during the reference portion of the GFC Wheel cycle.
Measurement / Reference Ratio	**MR Ratio**	-	The result of **CO MEAS** divided by **CO REF**. This ratio is the primary value used to compute CO concentration. The value displayed is not linearized.
Sample Pressure	**PRES**	In-Hg-A	The absolute pressure of the Sample gas as measured by a pressure sensor located inside the sample chamber.
Sample Flow	**SAMPLE FL**	cm^3/min	Sample mass flow rate as measured by the flow rate sensor in the sample gas stream.
Sample Temperature	**SAMP TEMP**	°C	The temperature of the gas inside the sample chamber.
Bench Temperature	**BENCH TEMP**	°C	Optical bench temperature.
Wheel Temperature	**WHEEL TEMP**	°C	GFC Wheel temperature.
Box Temperature	**BOX TEMP**	°C	The temperature inside the analyzer chassis.
O_2 Cell Temperature[3]	O_2 **CELL TEMP**[3]	°C	The current temperature of the O_2 sensor measurement cell.
Photo-detector Temp. Control Voltage	**PHT DRIVE**	mV	The drive voltage being supplied to the thermoelectric coolers of the IR photo-detector by the sync/demod Board.
Slope	**SLOPE**	-	The sensitivity of the instrument as calculated during the last calibration activity.
Offset	**OFFSET**	-	The overall offset of the instrument as calculated during the last calibration activity.
O_2 Sensor Slope [1]	O_2 **SLOPE**	-	O_2 slope, computed during zero/span calibration.
O_2 Sensor Offset [1]	O_2 **OFFSET**	-	O_2 offset, computed during zero/span calibration.
CO_2 Sensor Slope[2]	CO_2 **SLOPE**	-	CO_2 slope, computed during zero/span calibration.
CO_2 Sensor Offset [2]	CO_2 **OFFSET**	-	CO_2 offset, computed during zero/span calibration.
Current Time	**TIME**	-	The current time. This is used to create a time stamp on iDAS readings, and by the **AUTOCAL** feature to trigger calibration events.

[1] Only appears when the optional O_2 sensor is installed.
[2] Only appears when the optional CO_2 sensor is installed.
[3] Only available on the M300E.

6.3. WARNING MESSAGES

The most common instrument failures will be reported as a warning on the analyzer's front panel and through the **COMM** ports. Section 13.1.1 explains how to use these messages to troubleshoot problems. Section 6.3 shows how to view and clear warning messages.

Table 6-3: List of Warning Messages

MESSAGE	MEANING
ANALOG CAL WARNING	The instrument's A/D circuitry or one of its analog outputs is not calibrated.
BENCH TEMP WARNING	The temperature of the optical bench is outside the specified limits.
BOX TEMP WARNING	The temperature inside the chassis is outside the specified limits.
CANNOT DYN SPAN[2]	Remote span calibration failed while the dynamic span feature was set to turned on.
CANNOT DYN ZERO[3]	Remote zero calibration failed while the dynamic zero feature was set to turned on.
CONC ALRM1 WARNING[1]	Concentration alarm 1 is enabled and the measured CO level is ≥ the set point.
CONC ALRM2 WARNING[1]	Concentration alarm 2 is enabled and the measured CO level is ≥ the set point.
CONFIG INITIALIZED	Configuration storage was reset to factory configuration or erased.
DATA INITIALIZED	iDAS data storage was erased.
O_2 CELL TEMP WARN[2]	O_2 sensor cell temperature outside of warning limits.
PHOTO TEMP WARNING	The temperature of the IR photo detector is outside the specified limits.
REAR BOARD NOT DET	The CPU is unable to communicate with the motherboard.
RELAY BOARD WARN	The firmware is unable to communicate with the relay board.
SAMPLE FLOW WARN	The flow rate of the sample gas is outside the specified limits.
SAMPLE PRESS WARN	Sample gas pressure outside of operational parameters.
SAMPLE TEMP WARN	The temperature of the sample gas is outside the specified limits.
SOURCE WARNING	The IR source may be faulty.
SYSTEM RESET[1]	The computer was rebooted.
WHEEL TEMP WARNING	The Gas Filter Correlation Wheel temperature is outside the specified limits.

[1] Alarm warnings only present when 0ptional alarm package is activated.
[2] Only enabled when the optional O_2 Sensor is installed.

To view and clear warning messages:

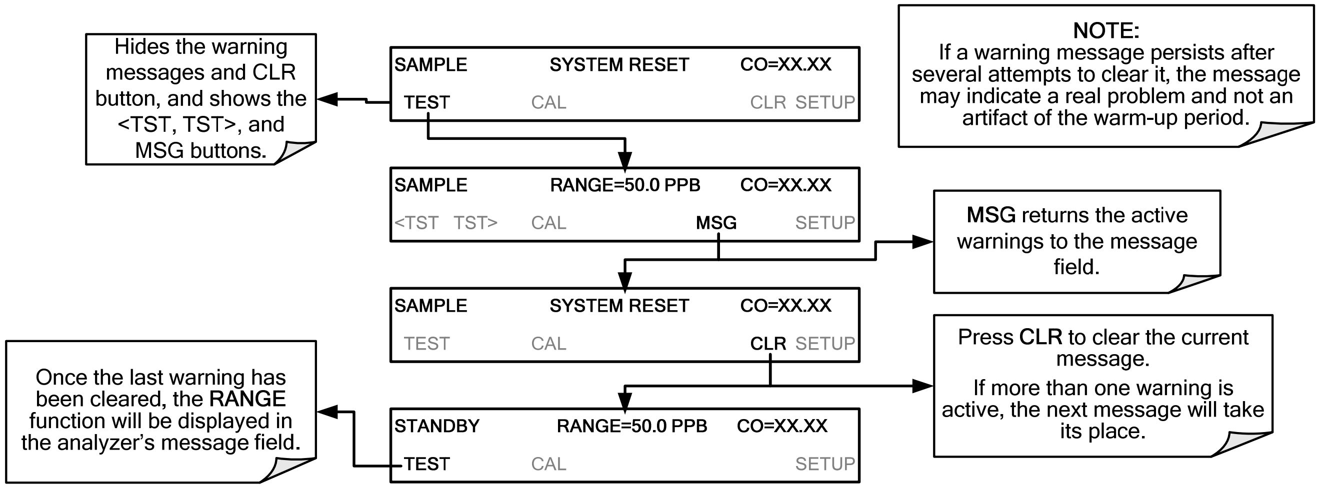


Figure 6-3: Viewing and Clearing M300E/EM WARNING Messages

6.4. CALIBRATION MODE

Press the CAL key to switch the M300E/EM into calibration mode. In this mode the user can, in conjunction with introducing zero or span gases of known concentrations into the analyzer, cause it to adjust and recalculate the slope (gain) and offset of the its measurement range. This mode is also used to check the current calibration status of the instrument.

- For more information about setting up and performing standard calibration operations or checks, see Section 9.
- For more information about setting up and performing EPA equivalent calibrations, see Section 10.

If the instrument includes one of the available zero/span valve options, the **SAMPLE** mode display will also include **CALZ** and **CALS** keys. Pressing either of these keys also puts the instrument into calibration mode.

The **CALZ** key is used to initiate a calibration of the analyzer's zero point using internally generated zero air.

The **CALS** key is used to calibrate the span point of the analyzer's current reporting range using span gas.

For more information concerning calibration valve options, see Section 5.6

For information on using the automatic calibration feature (**ACAL**) in conjunction with the one of the calibration valve options, see Section 9.4.

NOTE

It is recommended that this span calibration be performed at 80-90% of full scale of the analyzer's currently selected reporting range.

EXAMPLES:

If the reporting range is set for 0 to 50 ppm, an appropriate span point would be 40-45 ppm.

If the of the reporting range is set for 0 to 1000 ppb, an appropriate span point would be 800-900 ppb.

6.5. SETUP MODE

The **SETUP** mode contains a variety of choices that are used to configure the analyzer's hardware and software features, perform diagnostic procedures, gather information on the instruments performance and configure or access data from the internal data acquisition system (iDAS).

> **NOTE**
>
> **Any changes made to a variable during one of the following procedures is not acknowledged by the instrument until the ENTR Key is pressed.**
>
> **If the EXIT key is pressed before the ENTR key, the analyzer will beep alerting the user that the newly entered value has been lost.**

For a visual representation of the software menu trees, refer to Appendix A-1.

The areas accessible under the **SETUP** mode are shown in Table 6-4 and Table 6-5:

Table 6-4: Primary Setup Mode Features and Functions

MODE OR FEATURE	KEYPAD LABEL	DESCRIPTION	MANUAL SECTION
Analyzer Configuration	**CFG**	Lists key hardware and software configuration information	6.5.1
Auto Cal Feature	**ACAL**	Used to set up and operate the AutoCal feature. Only appears if the analyzer has one of the internal valve options installed.	6.5.2 and 9.4
Internal Data Acquisition (iDAS)	**DAS**	Used to set up the iDAS system and view recorded data	7.1
Analog Output Reporting Range Configuration	**RNGE**	Used to configure the output signals generated by the instruments Analog outputs.	6.6
Calibration Password Security	**PASS**	Turns the calibration password feature ON/OFF.	6.5.3
Internal Clock Configuration	**CLK**	Used to Set or adjust the instrument's internal clock.	6.5.4
Advanced **SETUP** features	**MORE**	This button accesses the instruments secondary setup menu.	See Table 6-5

Table 6-5: Secondary Setup Mode Features and Functions

MODE OR FEATURE	KEYPAD LABEL	DESCRIPTION	MANUAL SECTION
External Communication Channel Configuration	**COMM**	Used to set up and operate the analyzer's various serial channels including RS-232,RS-485, modem communication and/or Ethernet access.	8.1
System Status Variables	**VARS**	Used to view various variables related to the instruments current operational status. • Changes made to any variable are not recorded in the instrument's memory until the **ENTR** key is pressed. • Pressing the **EXIT** key ignores the new setting.	7.2
System Diagnostic Features and Analog Output Configuration	**DIAG**	Used to access a variety of functions that are used to configure, test or diagnose problems with a variety of the analyzer's basic systems. Most notably, the menus used to configure the output signals generated by the instruments Analog outputs are located here.	7.3
Alarm Limit Configuration[1]	**ALRM**	Used to turn the instrument's two alarms on and off as well as set the trigger limits for each.	7.5

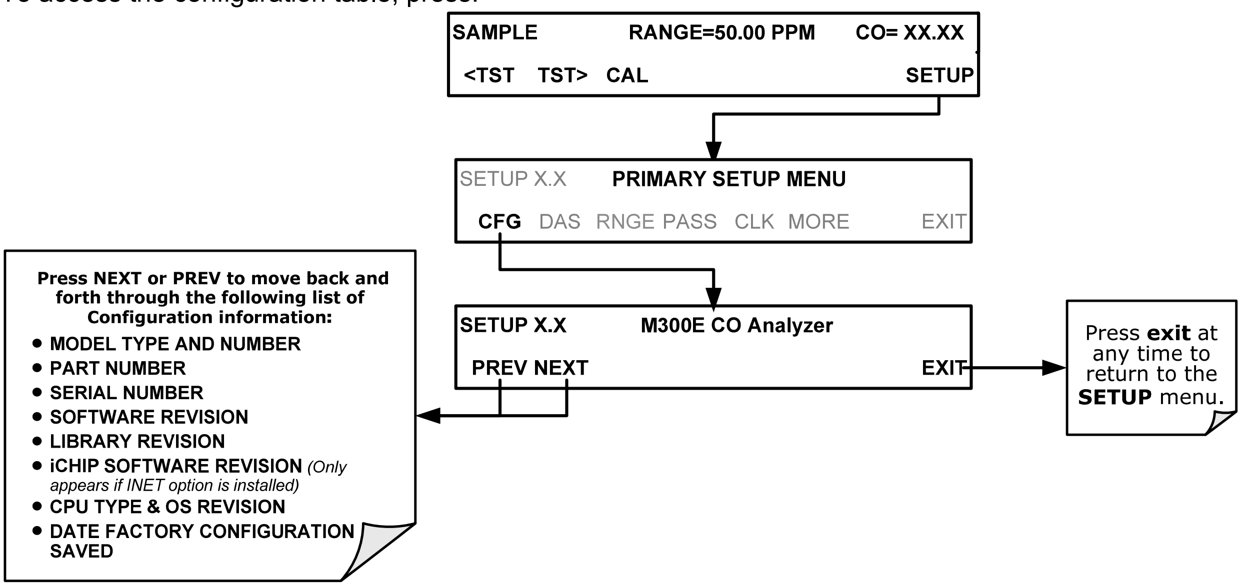
[1] Alarm warnings only present when optional alarm package is activated.

6.5.1. SETUP → CFG: CONFIGURATION INFORMATION

Pressing the **CFG** key displays the instrument's configuration information. This display lists the analyzer model, serial number, firmware revision, software library revision, CPU type and other information.

- Special instrument or software features or installed options may also be listed here.
- Use this information to identify the software and hardware installed in your M300E/EM Analyzer when contacting customer service.

To access the configuration table, press:

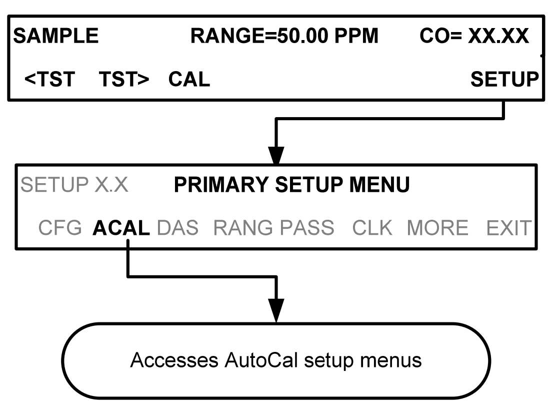


6.5.2. SETUP → ACAL: AUTOMATIC CALIBRATION

Instruments with one of the internal valve options installed can be set to automatically run calibration procedures and calibration checks. These automatic procedures are programmed using the submenus and functions found under the **ACAL** menu.

A menu tree showing the **ACAL** menu's entire structure can be found in Appendix A-1 of this manual.

Instructions for using the **ACAL** feature are located in the Section 9.4 of this manual along with all other information related to calibrating the M300E/EM Analyzer.



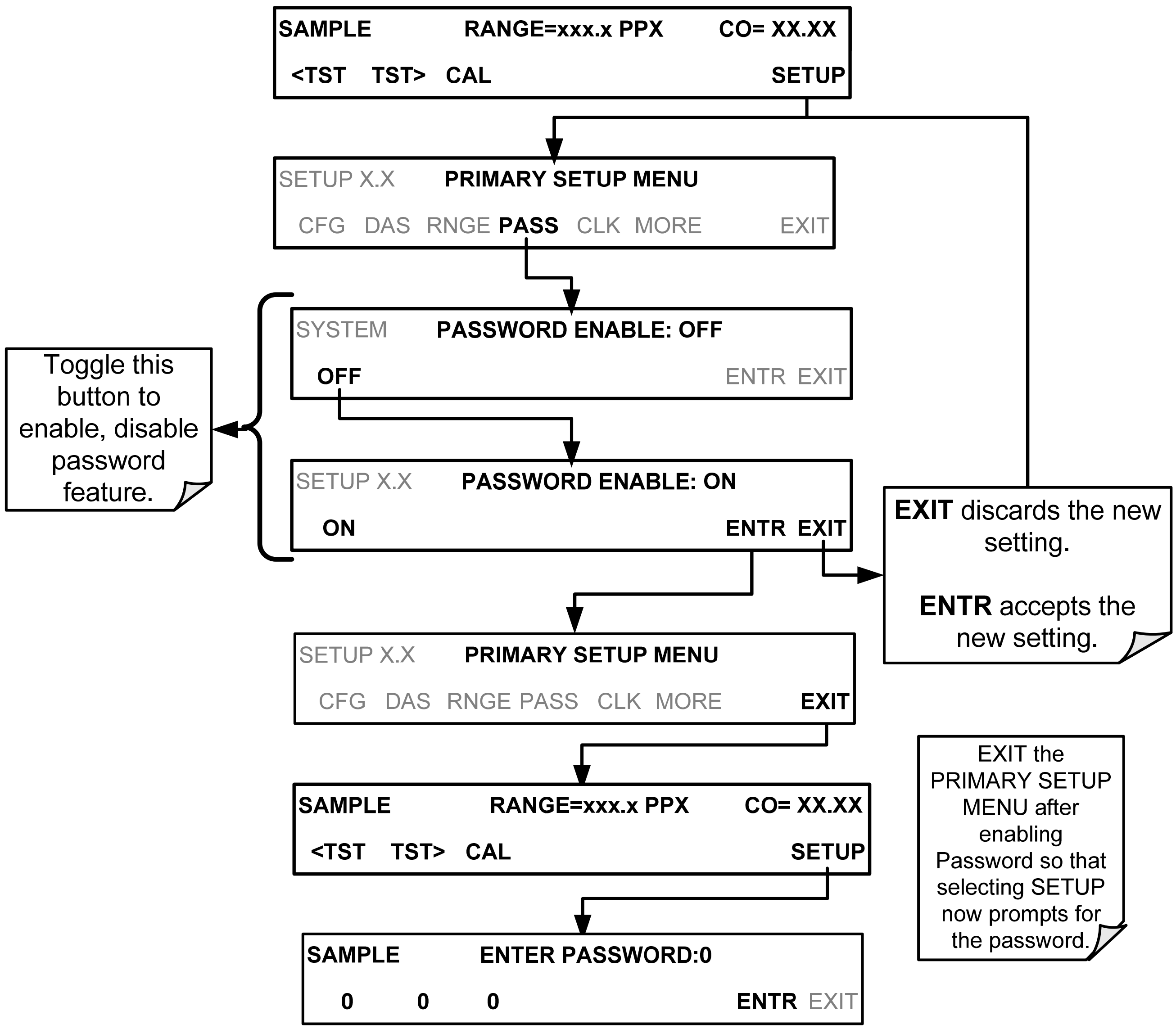
6.5.3. SETUP → PASS: PASSWORD FEATURE

The M300E/EM provides password protection of the calibration and setup functions to prevent unauthorized adjustments. When the passwords have been enabled in the **PASS** menu item, the system will prompt the user for a password anytime a password-protected function (e.g., SETUP) is requested. This allows normal operation of the instrument, but requires the password (101) to access to the menus under SETUP. When PASSWORD is disabled (SETUP>OFF), any operator can enter the Primary Setup (SETUP) and Secondary Setup (SETUP>MORE) menus. Whether PASSWORD is enabled or disabled, a password (default 818) is required to enter the VARS or DIAG menus in the SETUP>MORE menu.

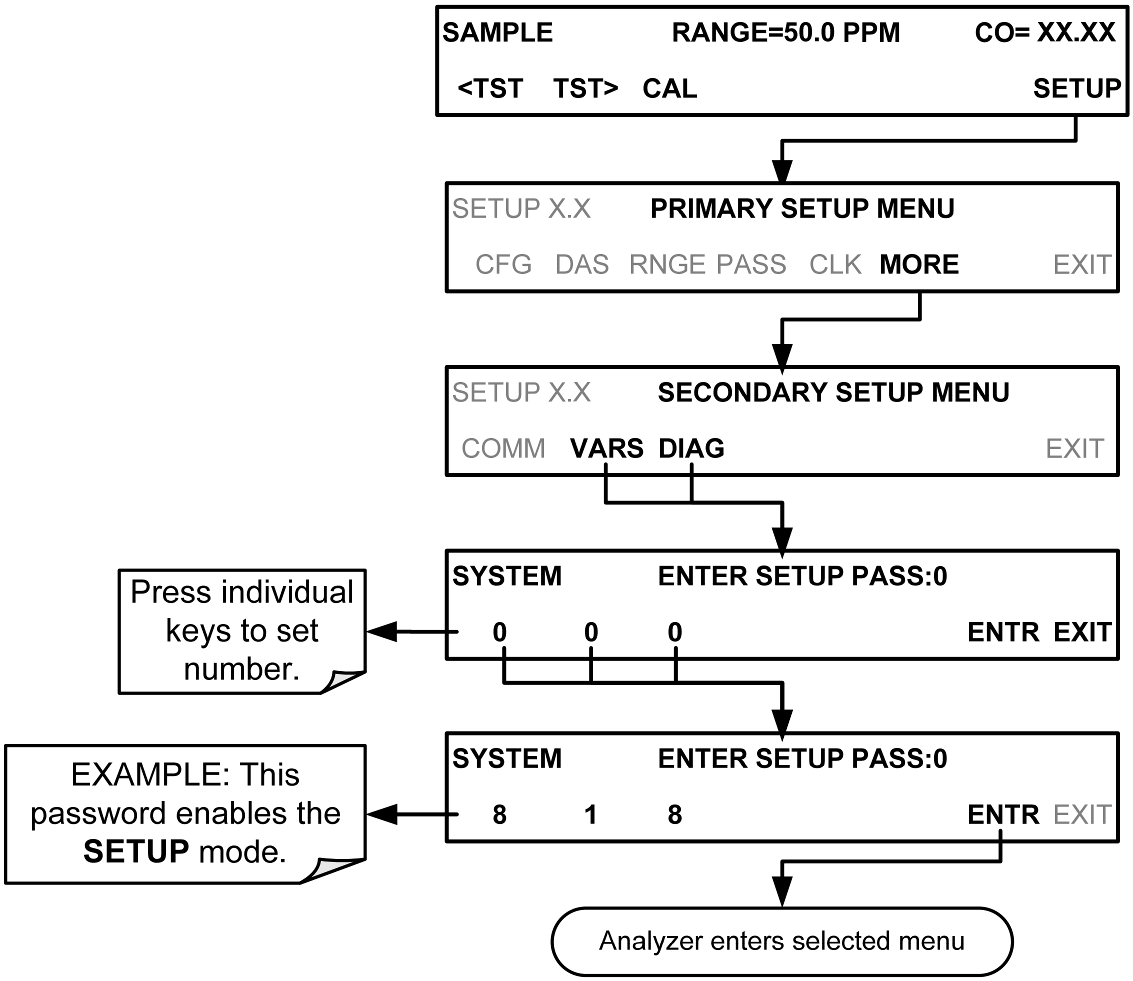
Table 6-6: Password Levels

PASSWORD	LEVEL	MENU ACCESS ALLOWED
Null (000)	Operation	All functions of the MAIN menu: **TEST, GEN,** initiate **SEQ , MSG, CLR**
101	Configuration/Maintenance	Access to Primary and Secondary SETUP Menus when PASSWORD enabled
818	Configuration/Maintenance	Access to Secondary SETUP Submenus **VARS** and **DIAG** whether PASSWORD is enabled or disabled.

To enable or disable passwords, press:


SAMPLE RANGE=xxx.x PPX CO= XX.XX
<TST TST> CAL SETUP
SETUP X.X PRIMARY SETUP MENU
CFG DAS RNGE PASS CLK MORE EXIT
SYSTEM PASSWORD ENABLE: OFF
OFF ENTR EXIT
Toggle this button to enable, disable password feature.
SETUP X.X PASSWORD ENABLE: ON
ON ENTR EXIT
EXIT discards the new setting.
ENTR accepts the new setting.
SETUP X.X PRIMARY SETUP MENU
CFG DAS RNGE PASS CLK MORE EXIT
EXIT the PRIMARY SETUP MENU after enabling Password so that selecting SETUP now prompts for the password.
SAMPLE RANGE=xxx.x PPX CO= XX.XX
<TST TST> CAL SETUP
SAMPLE ENTER PASSWORD:0
0 0 0 ENTR EXIT

Example: If all passwords are enabled, the following keypad sequence would be required to enter the **SETUP** menu:



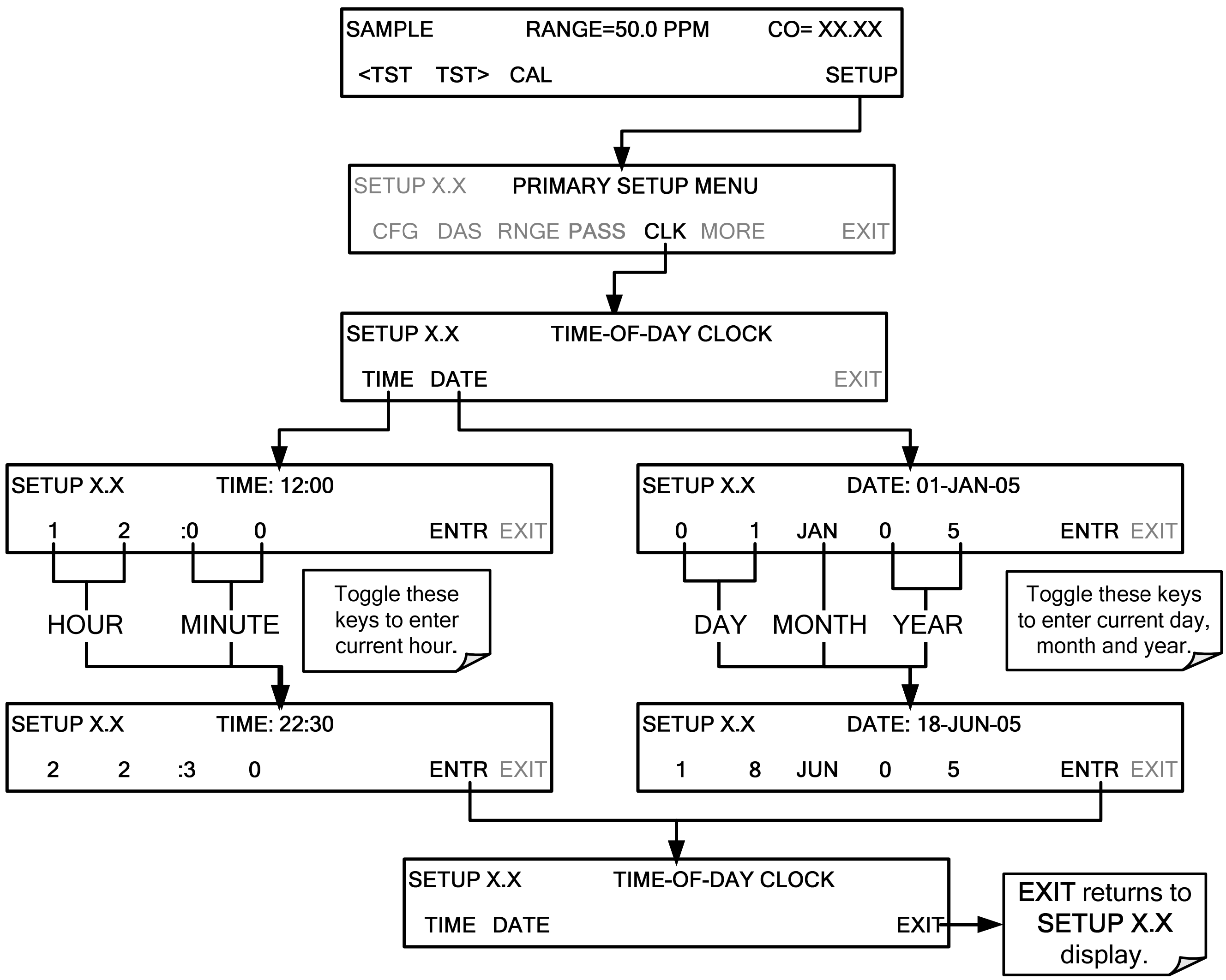
NOTE
The instrument still prompts for a password when entering the VARS and DIAG menus, even if passwords are disabled. It will display the default password (818) upon entering these menus.
The user only has to press ENTR to access the password-protected menus but does not have to enter the required number code.

6.5.4. SETUP → CLK: SETTING THE M300E/EM ANALYZER'S INTERNAL CLOCK

6.5.4.1. Setting the internal Clock's Time and Day

The M300E/EM has a time of day clock that supports the **DURATION** step of the automatic calibration (**ACAL**) sequence feature, time of day TEST function, and time stamps on for the iDAS feature and most COMM port messages.

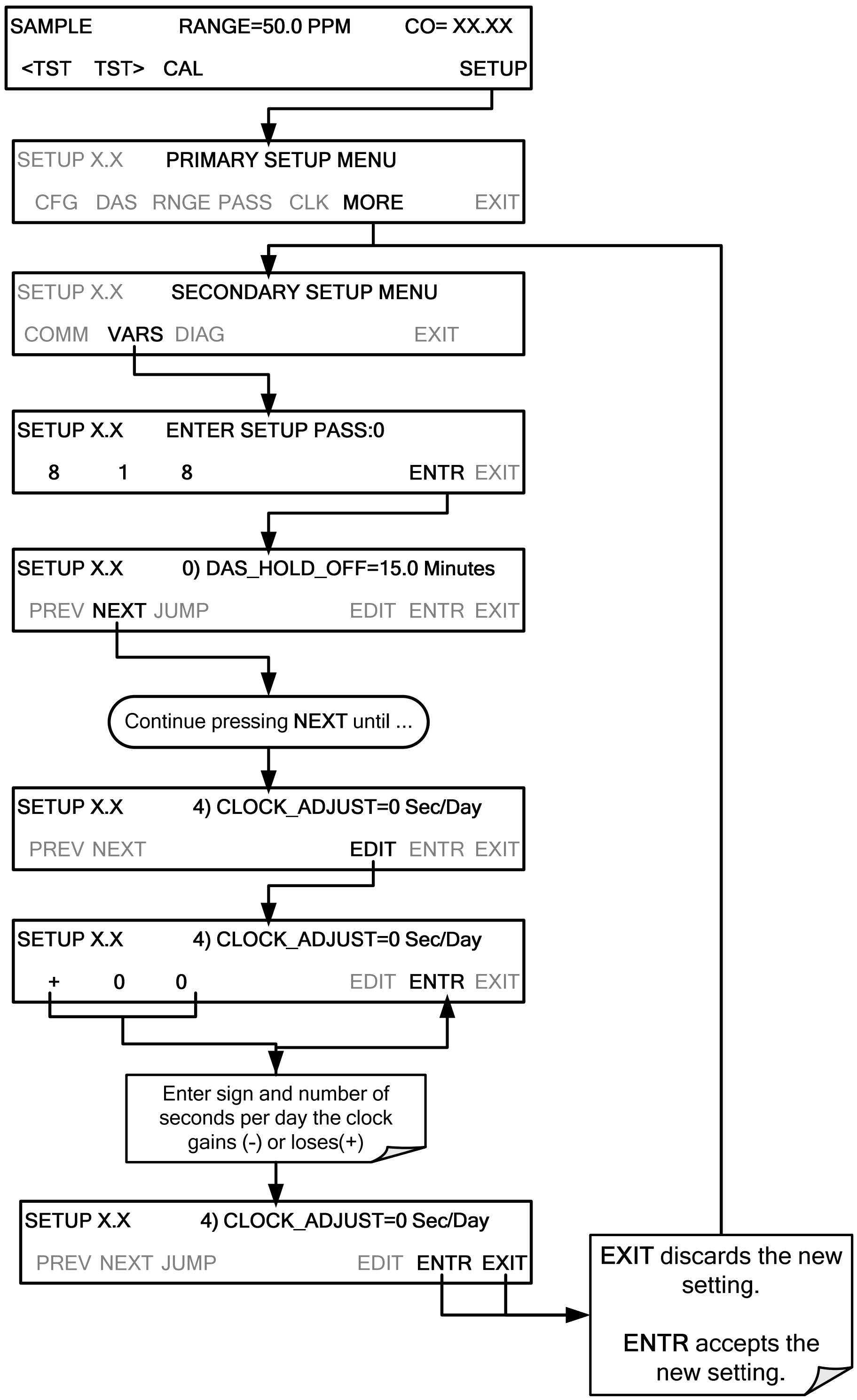
To set the clock's time and day, press:



6.5.4.2. **Adjusting the Internal Clock's Speed**

In order to compensate for CPU clocks which run faster or slower, you can adjust a variable called **CLOCK_ADJ** to speed up or slow down the clock by a fixed amount every day.

The **CLOCK_AD** variable is accessed via the **VARS** submenu: To change the value of this variable, press:



6.6. SETUP → RNGE: ANALOG OUTPUT REPORTING RANGE CONFIGURATION

6.6.1. PHYSICAL RANGE VERSUS ANALOG OUTPUT REPORTING RANGES

Functionally, the M300E Family of CO Analyzers have one hardware PHYSICAL RANGE that is capable of determining CO concentrations between across a very wide array of values.

Table 6-7: M300E Family Physical range by Model

MODEL	RANGE
M300E	0 – 1000 ppm
M300EM	0 – 5000 ppm

This architecture improves reliability and accuracy by avoiding the need for extra, switchable, gain-amplification circuitry. Once properly calibrated, the analyzer's front panel will accurately report concentrations along the entire span of its physical range.

Because many applications use only a small part of the analyzer's full physical range, this can create data resolution problems for most analog recording devices. For example, in an application where an M300E is being used to measure an expected concentration of typically less than 50 ppm CO, the full scale of expected values is only 4% of the instrument's full 1000 ppm measurement range. Unmodified, the corresponding output signal would also be recorded across only 2.5% of the range of the recording device.

The M300E/EM Analyzers solve this problem by allowing the user to select a scaled reporting range for the analog outputs that only includes that portion of the physical range relevant to the specific application.

Only this REPORTING RANGE of the analog outputs is scaled, the physical range of the analyzer and the readings displayed on the front panel remain unaltered.

NOTE

Both the iDAS values stored in the CPU's memory and the concentration values reported on the front panel are unaffected by the settings chosen for the reporting range(s) of the instrument.

6.6.2. **ANALOG OUTPUT RANGES FOR CO CONCENTRATION**

The analyzer has several active analog output signals related accessible through a connector on the rear panel (see Figure 3-2).

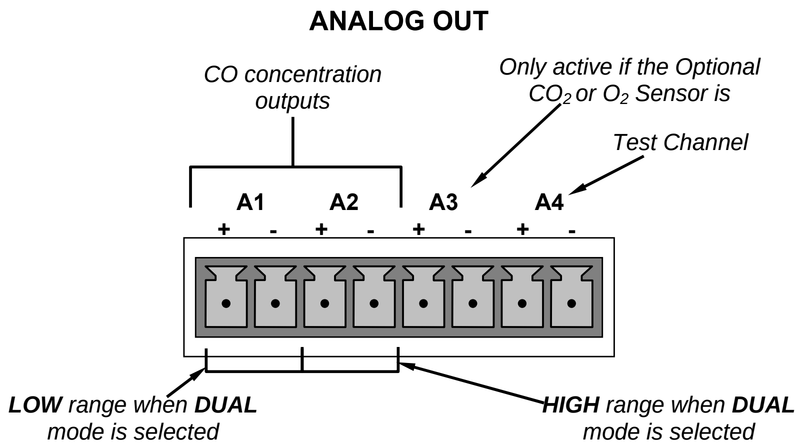


Figure 6-4: Analog Output Connector Pin Out

All four outputs can be configured either at the factory or by the user for full scale outputs of 0.1 VDC, 1VDC, 5VDC or 10VDC.

Additionally **A1, A2** and **A3** may be equipped with optional 0-20 mADC current loop drivers and configured for any current output within that range (e.g. 0-20, 2-20, 4-20, etc.). The user may also adjust the signal level and scaling of the actual output voltage or current to match the input requirements of the recorder or datalogger (See Section 7.4.5).

The **A1** and **A2** channels output a signal that is proportional to the CO concentration of the sample gas. Several modes are available which allow them to operate independently or be slaved together (See Section 6.6.3).

EXAMPLE:

A1 OUTPUT: Output Signal = 0-5 VDC representing 0-1000 ppm concentration values

A2 OUTPUT: Output Signal = 0 – 10 VDC representing 0-500 ppm concentration values.

Output **A3** is only active if the CO_2 or O_2 sensor option is installed. In this case a signal representing the currently measured CO_2 or O_2 concentration is output on this channel.

The output, labeled **A4** is special. It can be set by the user (See Section 7.4.6) to output several of the test functions accessible through the **<TST TST>** keys of the units sample display.

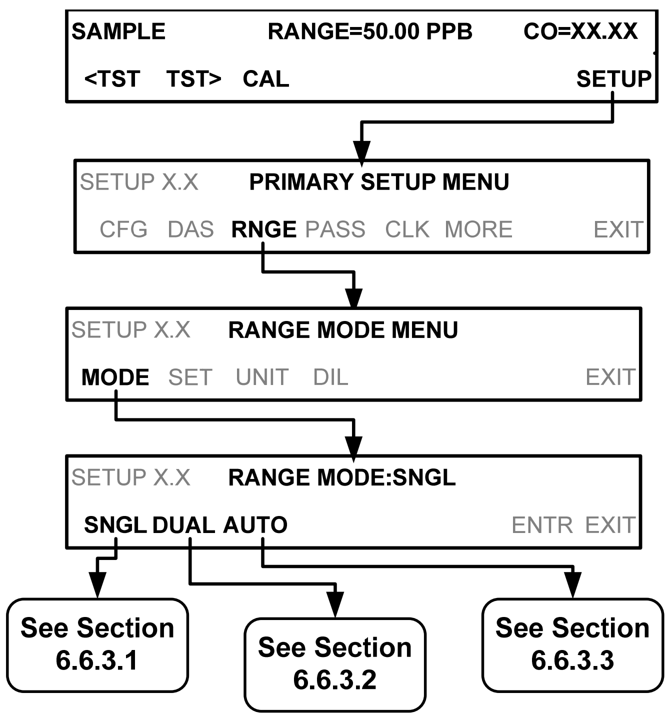
6.6.3. **REPORTING RANGE MODES**

The M300E/EM provides three analog output range modes to choose from.

- Single range (**SNGL**) mode sets a single maximum range for the analog output. If single range is selected both outputs are slaved together and will represent the same measurement span (e.g. 0-50 ppm), however their electronic signal levels may be configured for different ranges (e.g. 0-10 VDC vs. 0-.1 VDC).
- Dual range (**DUAL**) allows the A1 and A2 outputs to be configured with different measurement spans as well as separate electronic signal levels.
- Auto range (**AUTO**) mode gives the analyzer to ability to output data via a low range and high range. When this mode is selected the analyzer will automatically switch between the two ranges dynamically as the concentration value fluctuates.

Range status is also output via the external digital I/O status outputs (See Section 3.3.3).

To select the Analog Output Range Type press:



NOTE

Upper span limit setting for the individual range modes are shared. Resetting the span limit in one mode also resets the span limit for the corresponding range in the other modes as follows:

SNGL		**DUAL**		**AUTO**
Range	**←→**	**Range1**	**←→**	**Low Range**
		Range2	**←→**	**High Range**

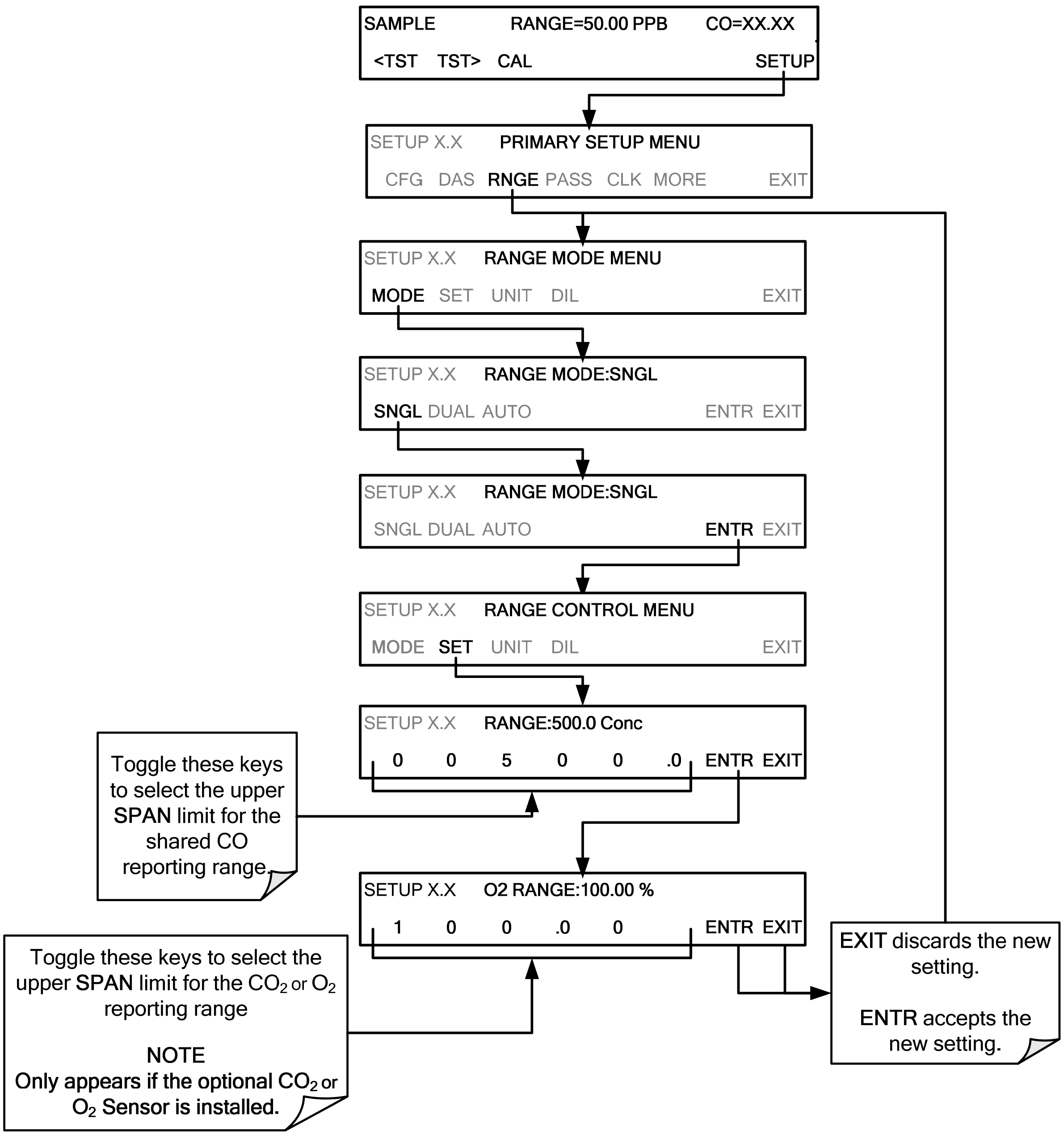
6.6.3.1. RNGE → MODE → SNGL: Configuring the M300E/EM Analyzer for SINGLE Range Mode

NOTE
This is the default reporting range mode for the analyzer.

When the single range mode is selected (**SNGL**), all analog CO concentration outputs (**A1 and A2**) are slaved together and set to the same reporting range limits (e.g. 500.0 ppb). The span limit of this reporting range can be set to any value within the physical range of the analyzer.

Although both outputs share the same concentration reporting range, the electronic signal ranges of the analog outputs may still be configured for different values (e.g. 0-5 VDC, 0-10 VDC, etc; see Section 7.4.2)

To select **SNGL** range mode and to set the upper limit of the range, press:



6.6.3.2. **RNGE → MODE → DUAL: Configuring the M300E/EM Analyzer for DUAL Range Mode**

Selecting the **DUAL** range mode allows the **A1** and **A2** outputs to be configured with different reporting ranges. The analyzer software calls these two ranges low and high.

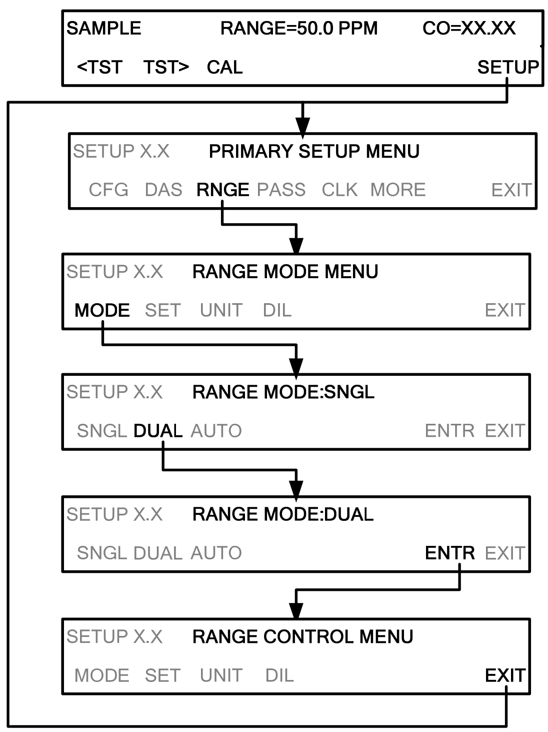
- The **LOW** range setting corresponds with the analog output labeled **A1** on the rear panel of the instrument.
- The **HIGH** range setting corresponds with the **A2** output.

While the software names these two ranges low and high, they do not have to be configured that way. For example: The low range can be set for a span of 0-1000 ppm while the high range is set for 0-500 ppm.

In **DUAL** range mode the **RANGE** test function displayed on the front panel will be replaced by two separate functions:

- **RANGE1**: The range setting for the A1 output.
- **RANGE2**: The range setting for the A2 output.

To select the **DUAL** range mode press following keystroke sequence



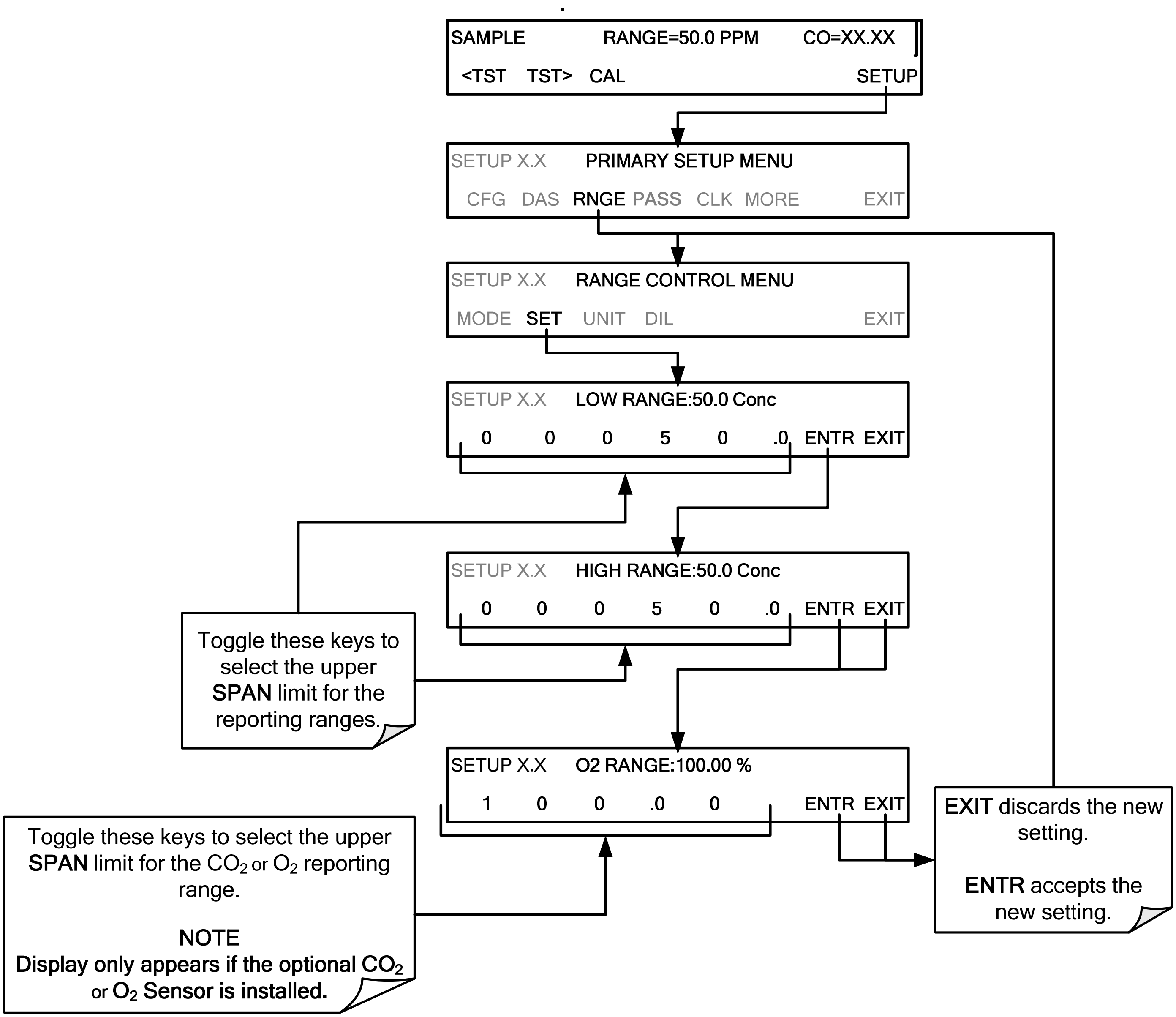
When the instrument's range mode is set to Dual the concentration field in the upper right hand corner of the display alternates between displaying the low range value and the high range value. The concentration currently being displayed is identified as follows: **C1**= **LOW** (or **A1**) and **C2** = **HIGH** (or **A2**).

NOTE

In DUAL range mode the LOW and HIGH ranges have separate slopes and offsets for computing CO concentrations.

The two ranges must be independently calibrated.

To set the upper range limit for each independent reporting range, press:



6.6.3.3. RNGE → MODE → AUTO: Configuring the M300E/EM Analyzer for AUTO Range Mode

In **AUTO** range mode, the analyzer automatically switches the reporting range between two user-defined ranges (low and high).

- The unit will switch from low range to high range when the CO_2 concentration exceeds 98% of the low range span.
- The unit will return from high range back to low range once both the CO_2 concentration falls below 75% of the low range span.

In **AUTO** Range Mode the instrument reports the same data in the same range on both the **A1** and **A2** outputs and automatically switches both outputs between ranges as described above.

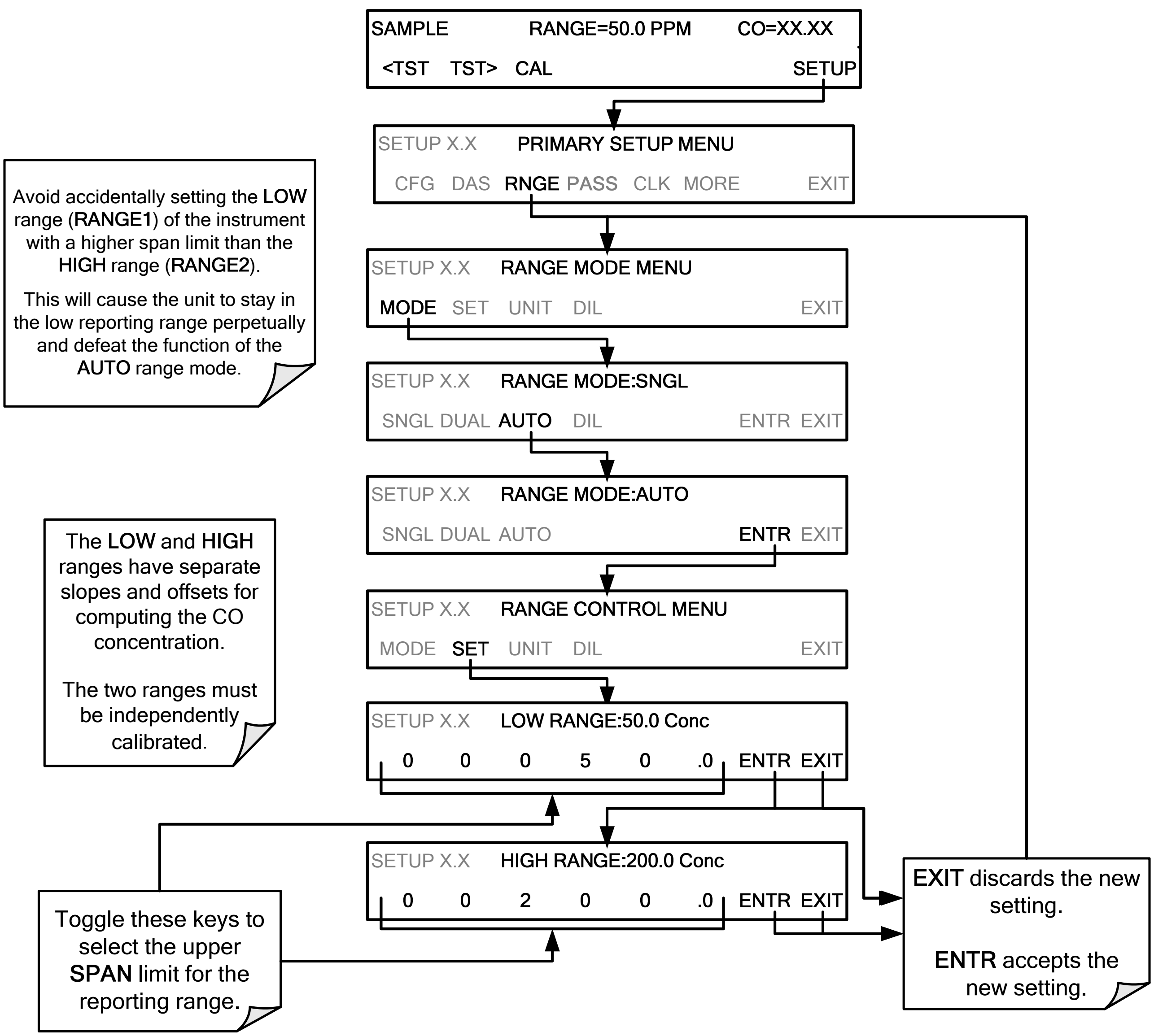
Also the **RANGE** test function displayed on the front panel will be replaced by two separate functions:

RANGE1: The **LOW** range setting for all analog outputs.

RANGE2: The **HIGH** range setting for all analog outputs.

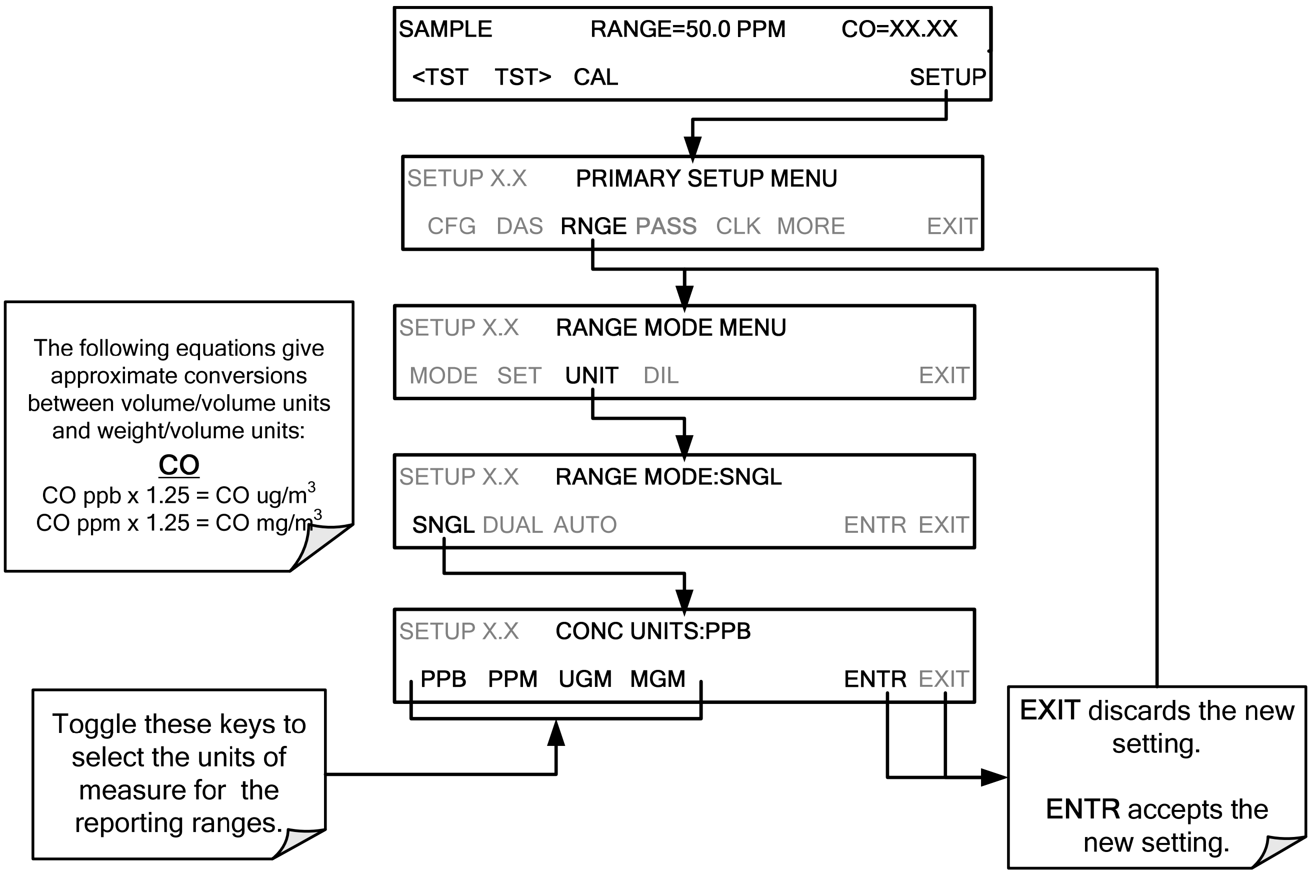
The high/low range status is also reported through the external, digital status bits (See Section 3.3.3).

To set individual ranges press the following keystroke sequence.



6.6.4. SETUP → RNGE → UNIT: SETTING THE REPORTING RANGE UNITS OF MEASURE

The M300E/EM can display concentrations in parts per million (10^6 mols per mol, PPM) or milligrams per cubic meter (mg/m^3, MG). Changing units affects all of the display, COMM port and iDAS values for all reporting ranges regardless of the analyzer's range mode. To change the concentration units:



NOTE
In order to avoid a reference temperature bias, the analyzer must be recalibrated after every change in reporting units.

NOTE

Concentrations displayed in mg/m^3 and ug/m^3 use 0°C @ 760 mmHg for Standard Temperature and Pressure (STP).

Consult your local regulations for the STP used by your agency.
***(Example: US EPA uses 25°C as the reference temperature)*.**

Once the Units of Measurement have been changed from volumetric (ppb or ppm) to mass units (µg/m^3 or mg/m^3) the analyzer MUST be recalibrated, as the "expected span values" previously in effect will no longer be valid.

Simply entering new expected span values without running the entire calibration routine IS NOT sufficient.

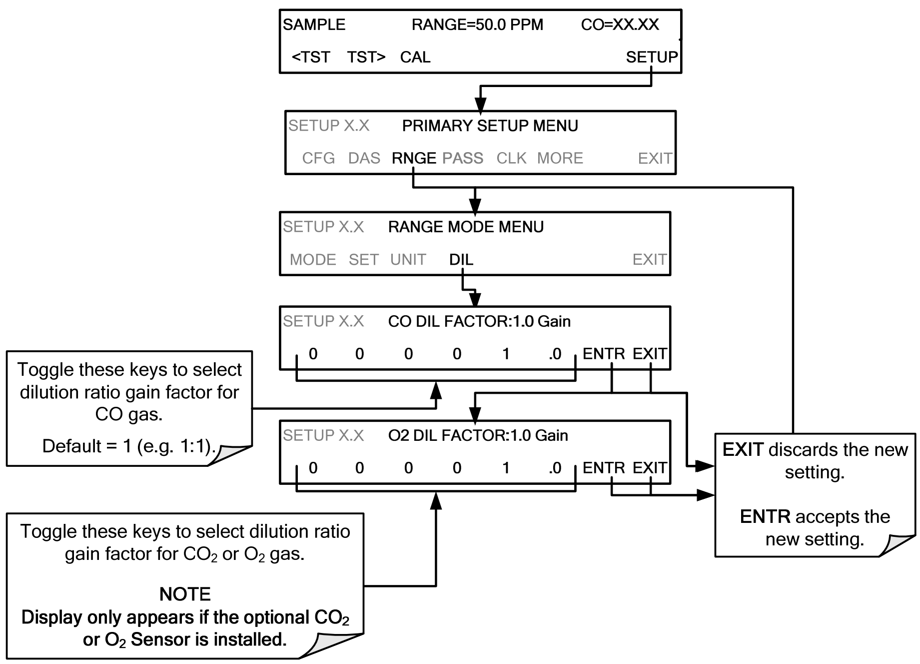
This will also counteract any discrepancies between STP definitions.

6.6.5. SETUP →RNGE → DIL: USING THE OPTIONAL DILUTION RATIO FEATURE

This feature is a optional software utility that allows the user to compensate for any dilution of the sample gas that may occur before it enters the sample inlet. Typically this occurs in continuous emission monitoring (CEM) applications where the sampling method used to remove the gas from the stack dilutes it.

Using the dilution ratio option is a 4-step process:

1. Select the appropriate units of measure (see Section 6.6.4).
2. Select the reporting range mode and set the reporting range upper limit (see Section 6.6.3). Make sure that:
   - The upper span limit entered for the reporting range is the maximum expected concentration of the **UNDILUTED** gas.
3. Set the dilution factor as a gain (e.g., a value of 20 means 20 parts diluent and 1 part of sample gas):



4. Calibrate the analyzer.
   - Make sure that the calibration span gas is either supplied through the same dilution system as the sample gas or has an appropriately lower actual concentration.

EXAMPLE: If the reporting range limit is set for 100 ppm and the dilution ratio of the sample gas is 20 gain, either:

a span gas with the concentration of 100 ppm can be used if the span gas passes through the same dilution steps as the sample gas, or;

a 5 ppm span gas must be used if the span gas **IS NOT** routed through the dilution system.

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7. ADVANCED FEATURES

7.1. SETUP → IDAS: USING THE DATA ACQUISITION SYSTEM (IDAS)

The M300E/EM Analyzer contains a flexible and powerful, Internal Data Acquisition System (iDAS) that enables the analyzer to store concentration and calibration data as well as a host of diagnostic parameters. The iDAS of the M300E/EM can store up to about one million data points, which can, depending on individual configurations, cover days, weeks or months of valuable measurements. The data is stored in non-volatile memory and is retained even when the instrument is powered off. Data is stored in plain text format for easy retrieval and use in common data analysis programs (such as spreadsheet-type programs).

The iDAS is designed to be flexible, users have full control over the type, length and reporting time of the data. The iDAS permits users to access stored data through the instrument's front panel or its communication ports.

The principal use of the iDAS is logging data for trend analysis and predictive diagnostics, which can assist in identifying possible problems before they affect the functionality of the analyzer. The secondary use is for data analysis, documentation and archival in electronic format.

To support the iDAS functionality, Teledyne API offers APICOM, a program that provides a visual interface for remote or local setup, configuration and data retrieval of the iDAS. The APICOM manual, which is included with the program, contains a more detailed description of the iDAS structure and configuration, which is briefly described in this manual.

The M300E/EM is configured with a basic iDAS configuration, which is enabled by default. New data channels are also enabled by default at their creation, but all channels may be turned off for later or occasional use.

Note

iDAS operation is suspended whenever its configuration is edited using the analyzer's front panel and therefore data may be lost. To prevent such data loss, it is recommended to use the APICOM graphical user interface for iDAS changes.

Please be aware that all stored data will be erased if the analyzer's Disk-on-Module or CPU board is replaced or if the configuration data stored there is reset.

Since all changes to the configuration of the iDAS cause all of the existing data to be erased, it is recommended to download your stored data prior to making any changes.

7.1.1. IDAS STATUS

The green SAMPLE LED on the instrument front panel, which indicates the analyzer status, also indicates certain aspects of the iDAS status:

Table 7-1: Front Panel LED Status Indicators for iDAS

LED STATE	IDAS STATUS
Off	System is in calibration mode. Data logging can be enabled or disabled for this mode. Calibration data are typically stored at the end of calibration periods, concentration data are typically not sampled, diagnostic data should be collected.
Blinking	Instrument is in hold-off mode, a short period after the system exits calibrations. iDAS channels can be enabled or disabled for this period. Concentration data are typically disabled whereas diagnostic should be collected.
On	Sampling normally.

The iDAS can be disabled, as opposed to suspended, only by disabling or deleting its individual data channels.

7.1.2. IDAS STRUCTURE

The iDAS is designed around the feature of a "record". A record is a single data point. The type of data recorded in a record is defined by two properties:

PARAMETER type that defines the kind of data to be stored (e.g. the average of gas concentrations measured with three digits of precision). See Section 7.1.5.3.

A **TRIGGER** event that defines when the record is made (e.g. timer; every time a calibration is performed, etc.). See Section 7.1.5.2.

The specific **PARAMETERS** and **TRIGGER** events that describe an individual record are defined in a construct called a **DATA CHANNEL** (see Section 7.1.3). Each data channel is related one or more parameters with a specific trigger event and various other operational characteristics related to the records being made (e.g. the channels name, number or records to be made, time period between records, whether or not the record is exported via the analyzer's RS-232 port, etc.).

7.1.2.1. iDAS Channels

The key to the flexibility of the iDAS is its ability to store a large number of combinations of triggering events and data parameters in the form of data channels. Users may create up to 50 data channels and each channel can contain one or more parameters. For each channel, the following are selected:

- One triggering event is selected.
- Up to 50 data parameters, which can be the shared between channels.
- Several other properties that define the structure of the channel and allow the user to make operational decisions regarding the channel.

Table 7-2: iDAS Data Channel Properties

PROPERTY	DESCRIPTION	DEFAULT SETTING	SETTING RANGE
NAME	The name of the data channel.	**"NONE"**	Up to 6 letters or digits [1.]
TRIGGERING EVENT	The event that triggers the data channel to measure and store the datum.	**ATIMER**	Any available event (see Appendix A-5).
NUMBER AND LIST OF PARAMETERS	A User-configurable list of data types to be recorded in any given channel.	**1** (COMEAS)	Any available parameter (see Appendix A-5).
REPORT PERIOD	The amount of time between each channel data point.	**000:01:00** *(1 hour)*	000:00:01 to 366:23:59 (Days:Hours:Minutes)
NUMBER OF RECORDS	The number of reports that will be stored in the data file. Once the limit is exceeded, the oldest data is over-written.	**100**	1 to 1 million, limited by available storage space.
RS-232 REPORT	Enables the analyzer to automatically report channel values to the RS-232 ports.	**OFF**	OFF or ON
CHANNEL ENABLED	Enables or disables the channel. Allows a channel to be temporarily turned off without deleting it.	**ON**	OFF or ON
CAL HOLD OFF	Disables sampling of data parameters while instrument is in calibration mode [2].	**OFF**	OFF or ON

[1] More with APICOM, but only the first six are displayed on the front panel.

[2] When enabled records are not recorded until the DAS HOLD OFF period is passed after calibration mode. DAS HOLD OFF SET in the **VARS** menu (see Section **Error! Reference source not found.**).

7.1.3. **DEFAULT IDAS CHANNELS**

A set of default Data Channels has been included in the analyzer's software for logging CO concentration and certain predictive diagnostic data. These default channels include but are not limited to:

- **CONC:** Samples CO concentration at one minute intervals and stores an average every hour with a time and date stamp. Readings during calibration and calibration hold off are not included in the data.
  - By default, the last 800 hourly averages are stored.
- **PNUMTC:** Collects sample flow and sample pressure data at five-minute intervals and stores an average once a day with a time and date stamp. This data is useful for monitoring the condition of the pump and critical flow orifice (sample flow) and the sample filter (clogging indicated by a drop in sample pressure) over time to predict when maintenance will be required.
  - The last 360 daily averages (about 1 year) are stored.
- **CALDAT:** Logs new slope and offset of CO measurements every time a zero or span calibration is performed and the result changes the value of the slope (triggering event: **SLPCHG**). The CO stability data to evaluate if the calibration value was stable are also stored.
  - This data channel will store data from the last 200 calibrations and can be used to document analyzer calibration and is useful in the detection of the in slope and offset (instrument response) when performing predictive diagnostics as part of a regular maintenance schedule.
  - The CALDAT channel collects data based on events (e.g. a calibration operation) rather than a timed interval and therefore does not represent any specific length of time. As with all data channels, a date and time stamp is recorded for every logged data point.

These default Data Channels can be used as they are, or they can be customized from the front panel to fit a specific application. They can also be deleted to make room for custom user-programmed Data Channels.

Appendix A-5 lists the firmware-specific iDAS configuration in plain-text format. This text file can either be loaded into APICOM and then modified and uploaded to the instrument or can be copied and pasted into a terminal program to be sent to the analyzer.

NOTE

Sending an iDAS configuration to the analyzer through its COMM ports will replace the existing configuration and will delete all stored data. Back up any existing data and the iDAS configuration before uploading new settings.

Triggering Events and Data Parameters/Functions for these default channels are:

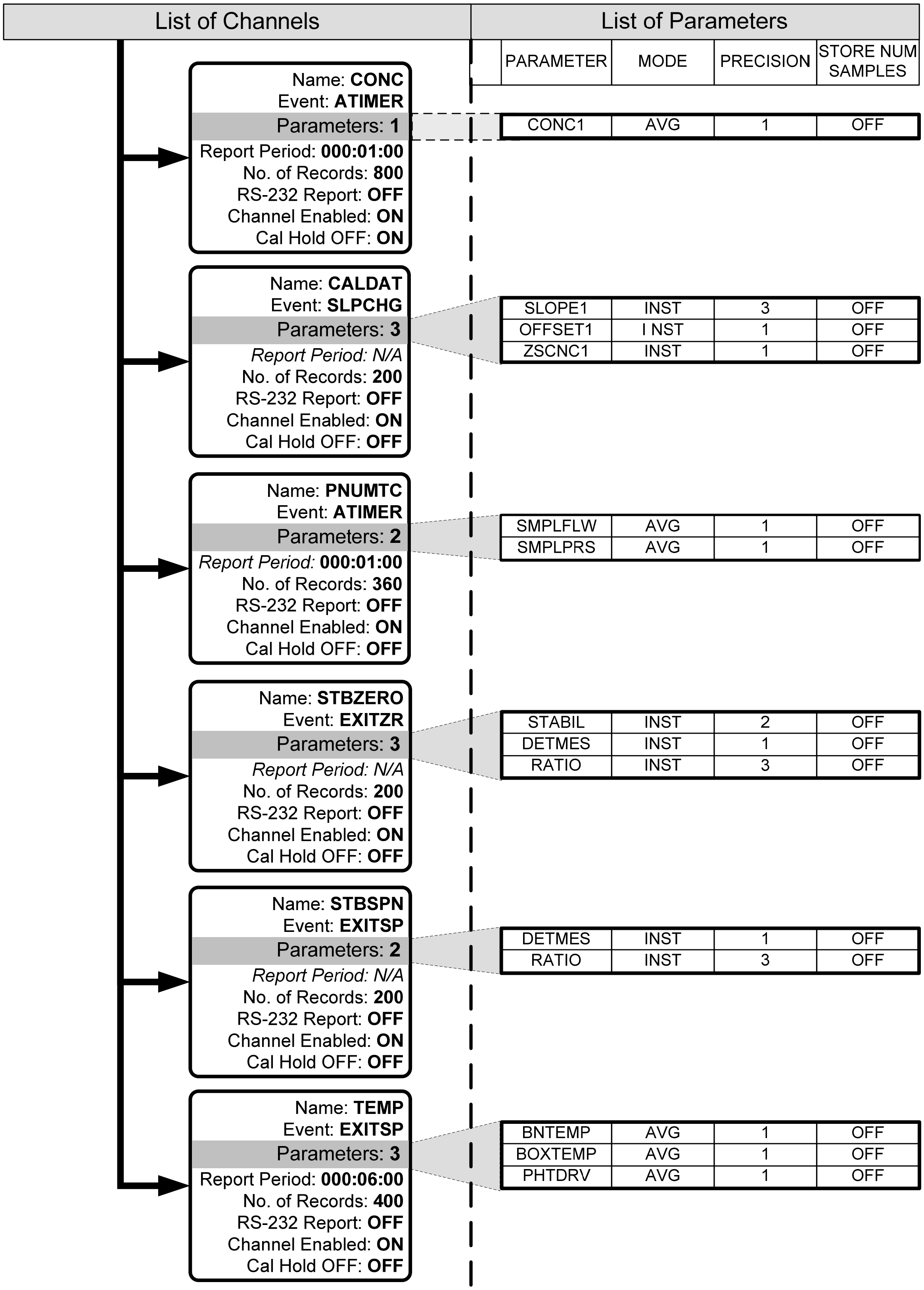
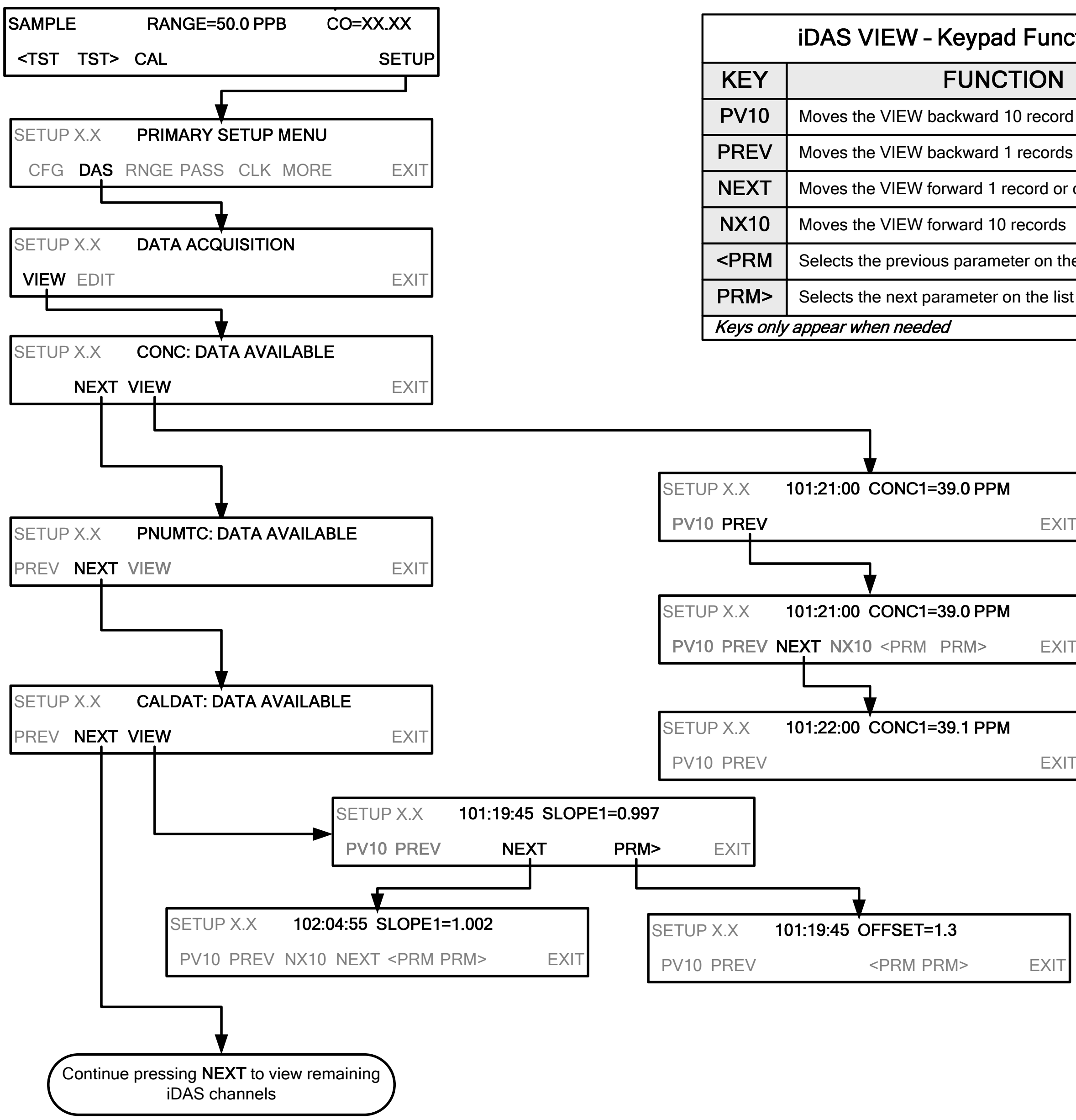


Figure 7-1: Default iDAS Channel Setup

7.1.4. SETUP →DAS →VIEW: VIEWING IDAS CHANNELS AND INDIVIDUAL RECORDS

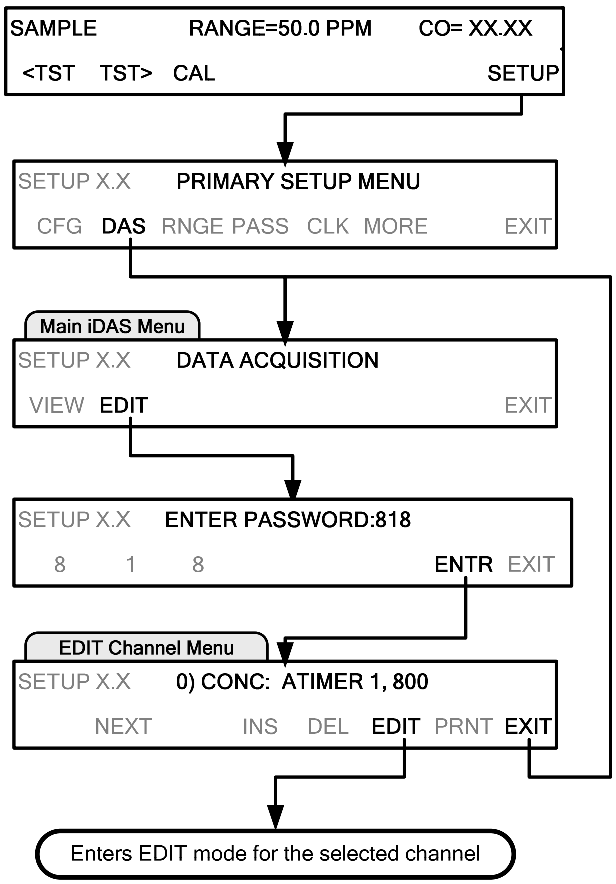
iDAS data and settings can be viewed on the front panel through the following keystroke sequence.



iDAS VIEW – Keypad Functions	
KEY	**FUNCTION**
PV10	Moves the VIEW backward 10 record
PREV	Moves the VIEW backward 1 records or channel
NEXT	Moves the VIEW forward 1 record or channel
NX10	Moves the VIEW forward 10 records
<PRM	Selects the previous parameter on the list
PRM>	Selects the next parameter on the list
Keys only appear when needed	

7.1.5. SETUP →DAS →EDIT: ACCESSING THE IDAS EDIT MODE

iDAS configuration is most conveniently done through the APICOM remote control program. The following list of key strokes shows how to edit the iDAS using the front panel.



iDAS EDIT – Keypad Functions	
KEY	**FUNCTION**
PREV	Selects the previous data channel in the list
NEXT	Selects the next data channel in the list
INS	Inserts a new data channel into the list BEFORE the selected channel
DEL	Deletes the currently selected data channel
EDIT	Enters EDIT mode
PRINT	Exports the configuration of all data channels to the RS-232 interface
Keys only appear when needed	

When editing the data channels, the top line of the display indicates some of the configuration parameters.

For example, the display line:

0) CONC: ATIMER, 1, 800

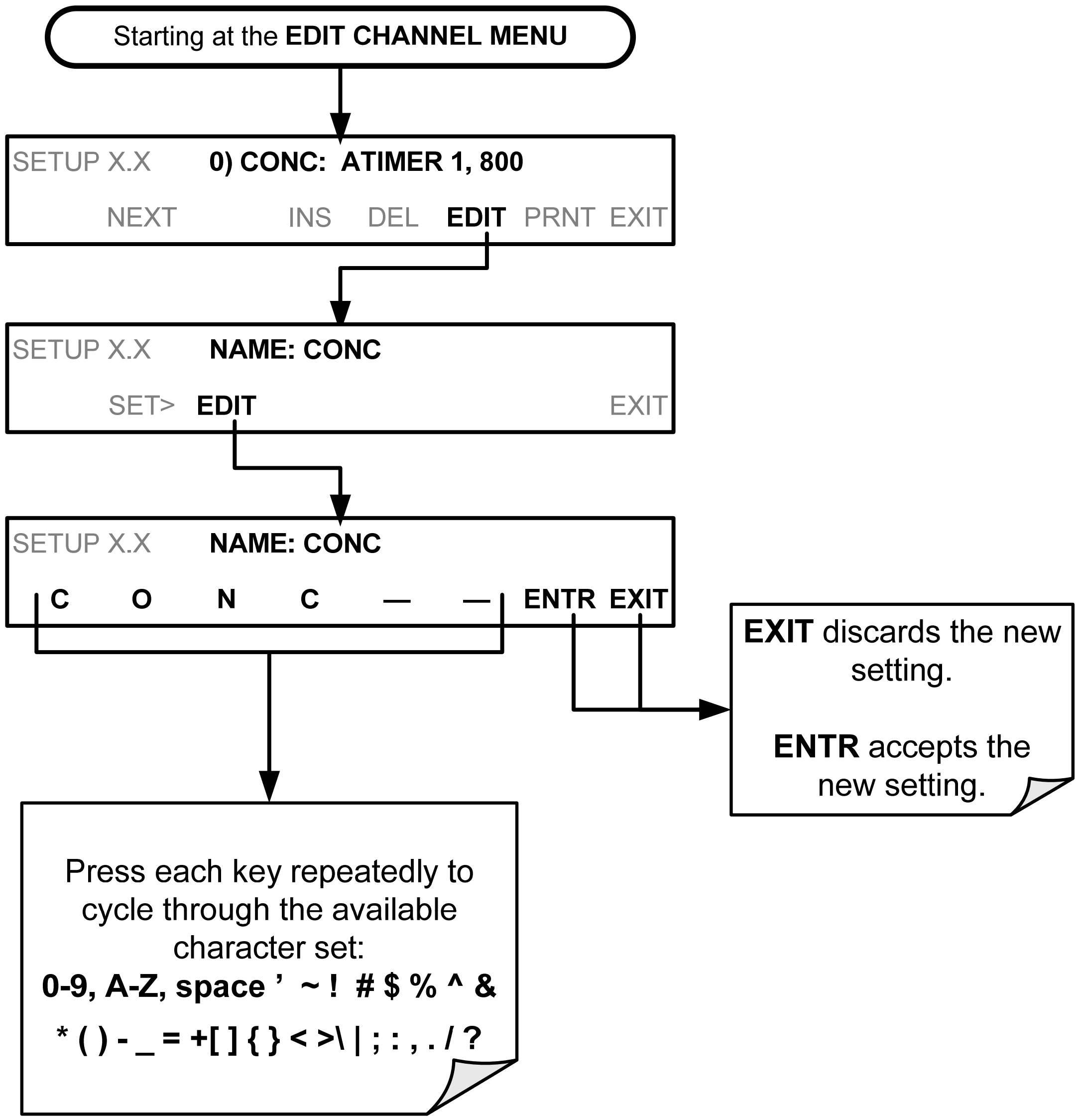
Translates to the following configuration:

Channel No.: 0
NAME: CONC
TRIGGER EVENT: ATIMER
PARAMETERS: One parameter is included in this channel
EVENT: This channel is set up to store 800 records.

To edit the name of a data channel, follow the above key sequence and refer to Section 7.1.5.1:

7.1.5.1. **Editing iDAS Data Channel Names**

To edit the name of an iDAS data channel, follow the instruction shown in Section 7.1.5.1, then press:



7.1.5.2. **Editing iDAS Triggering Events**

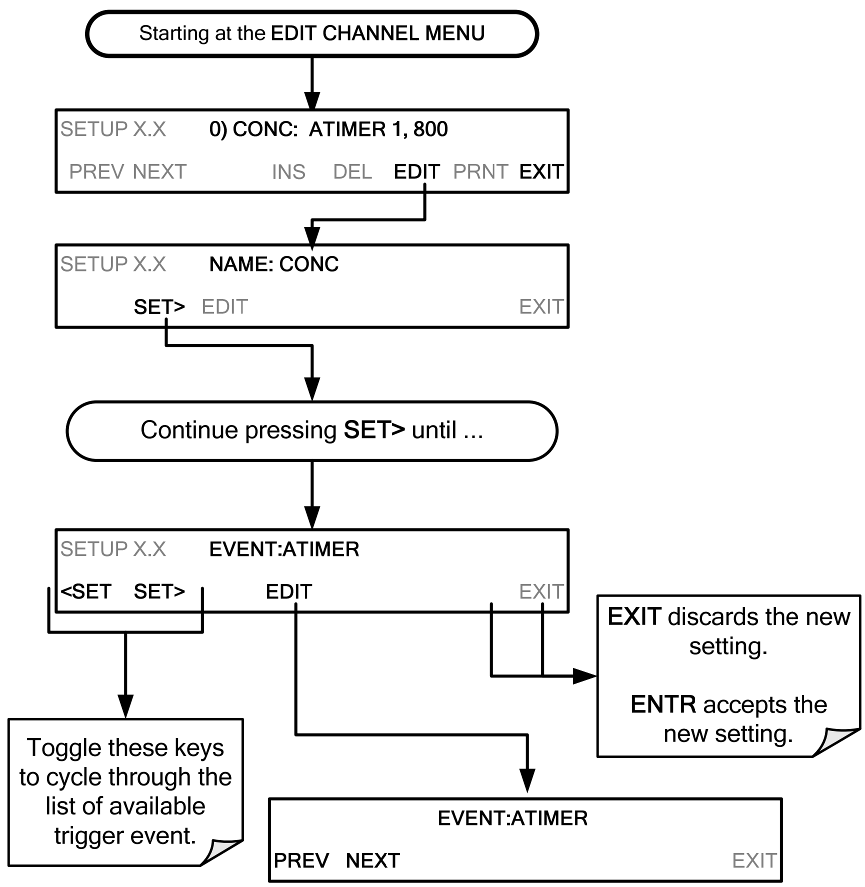
Triggering events define when and how the iDAS records a measurement of any given data channel. The most commonly used triggering events are:

ATIMER: Sampling at regular intervals specified by an automatic timer. Most trending information is usually stored at such regular intervals, which can be instantaneous or averaged.

EXITZR, **EXITSP**, and **SLPCHG** (exit zero, exit span, slope change): Sampling at the end of (irregularly occurring) calibrations or when the response slope changes. These triggering events create instantaneous data points, e.g., for the new slope and offset (concentration response) values at the end of a calibration. Zero and slope values are valuable to monitor response drift and to document when the instrument was calibrated.

WARNINGS: Some data may be useful when stored if one of several warning messages appears such as **WTEMPW** (GFC Wheel temperature warning). This is helpful for troubleshooting by monitoring when a particular warning occurrs.

To edit the list of data parameters associated with a specific data channel, follow the instruction shown in Section 7.1.5 then press:



NOTE

Triggering events are firmware-specific and a complete list of Triggers for this model analyzer can be found in Appendix A-5.

7.1.5.3. Editing iDAS Parameters

Data parameters are types of data that may be measured and stored by the iDAS. For each analyzer model, the list of available data parameters is different, fully defined and not customizable. Appendix A-5 lists firmware specific data parameters for the M300E/EM. iDAS parameters include things like CO concentration measurements, temperatures of the various heaters placed around the analyzer, pressures and flows of the pneumatic subsystem and other diagnostic measurements as well as calibration data such as stability, slope and offset.

Most data parameters have associated measurement units, such as mV, ppb, cm^3/min, etc., although some parameters have no units (e.g. **SLOPE**). With the exception of concentration readings, none of these units of measure can be changed. To change the units of measure for concentration readings, see Section 6.6.4.

Note

iDAS does not keep track of the units (i.e. PPM or PPB) of each concentration value therefore iDAS data files may contain concentrations data recorded in more than one the type of unit if the units of measure was changed during data acquisition.

Each data parameter has user-configurable functions that define how the data are recorded.

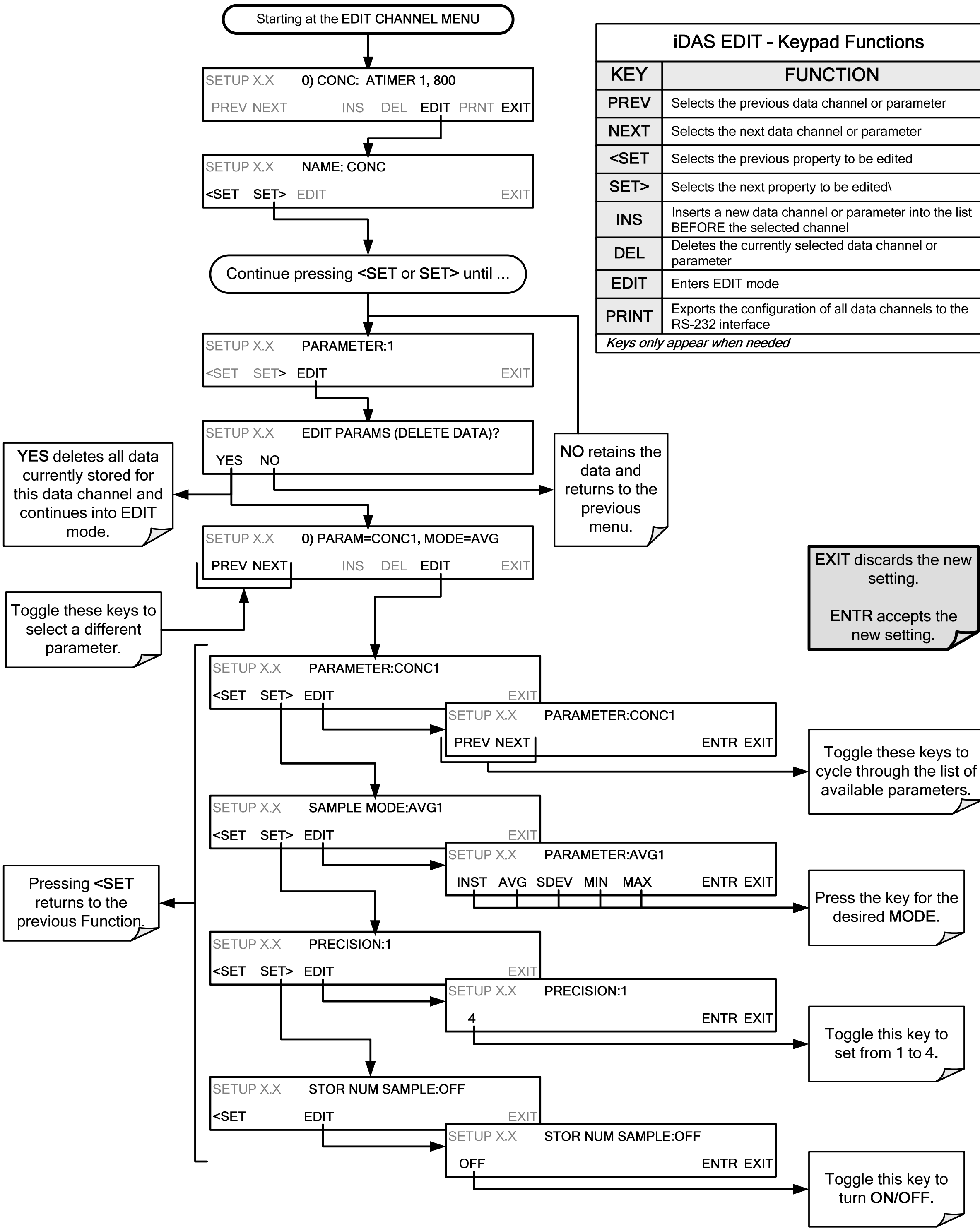
Table 7-3: iDAS Data Parameter Functions

FUNCTION	EFFECT
PARAMETER	Instrument-specific parameter name.
SAMPLE MODE	**INST:** Records instantaneous reading. **AVG:** Records average reading during reporting interval. **SDEV:** Records the standard deviation of the data points recorded during the reporting interval. **MIN:** Records minimum (instantaneous) reading during reporting interval. **MAX:** Records maximum (instantaneous) reading during reporting interval.
PRECISION	**0 to 4:** Sets the number of digits to the right decimal point for each record. Example: Setting **4**; **"399.9865 PPB"** Setting **0**; **"400 PPB"**
STORE NUM SAMPLES	**OFF:** Stores only the average (default). **ON:** Stores the average and the number of samples in used to compute the value of the parameter. This property is only useful when the AVG sample mode is used. Note that the number of samples is the same for all parameters in one channel and needs to be specified only for one of the parameters in that channel.

Users can specify up to 50 parameters per data channel (the M300E/EM provides about 40 parameters). However, the number of parameters and channels is ultimately limited by available memory.

Data channels can be edited individually from the front panel without affecting other data channels. However, when editing a data channel, such as during adding, deleting or editing parameters, all data for that particular channel will be lost, because the iDAS can store only data of one format (number of parameter columns, etc.) for any given channel. In addition, an iDAS configuration can only be uploaded remotely as an entire set of channels. Hence, remote update of the iDAS will always delete all current channels and stored data.

To modify, add or delete a parameter, follow the instruction shown in Section 7.1.5 then press:



iDAS EDIT – Keypad Functions	
KEY	**FUNCTION**
PREV	Selects the previous data channel or parameter
NEXT	Selects the next data channel or parameter
<SET	Selects the previous property to be edited
SET>	Selects the next property to be edited\
INS	Inserts a new data channel or parameter into the list BEFORE the selected channel
DEL	Deletes the currently selected data channel or parameter
EDIT	Enters EDIT mode
PRINT	Exports the configuration of all data channels to the RS-232 interface
Keys only appear when needed	

NOTE

When the STORE NUM SAMPLES feature is turned on, the instrument will store how many measurements were used to compute the AVG, SDEV, MIN or MAX value but not the actual measurements themselves.

7.1.5.4. **Editing Sample Period and Report Period**

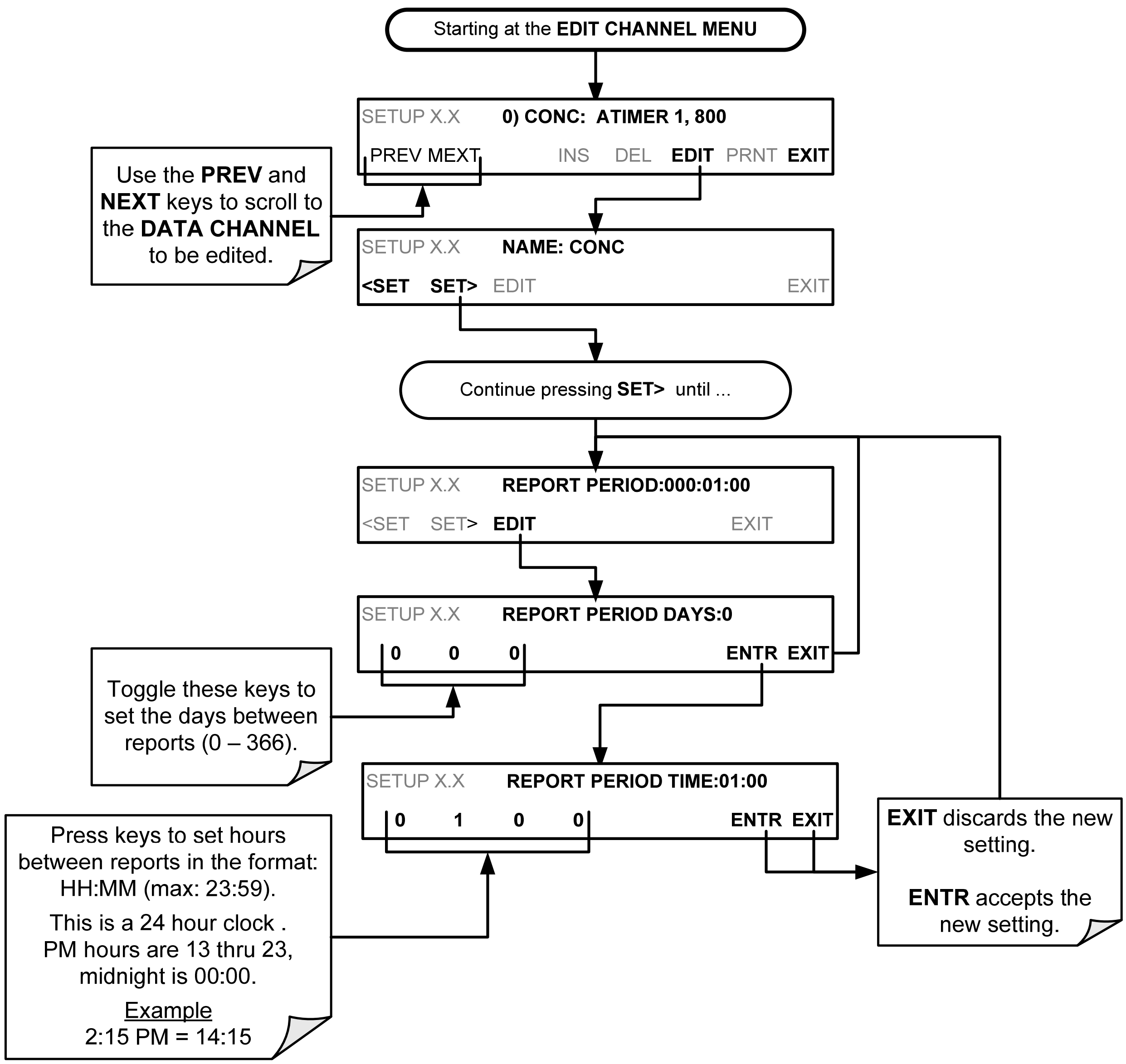
The iDAS defines two principal time periods by which sample readings are taken and permanently recorded:

SAMPLE PERIOD: Determines how often iDAS temporarily records a sample reading of the parameter in volatile memory. **SAMPLE PERIOD** is only used when the iDAS parameter's sample mode is set for **AVG**, **SDEV**, **MIN** or **MAX.**

The **SAMPLE PERIOD** is set to one minute by default and generally cannot be accessed from the standard iDAS front panel menu, but is available via the instruments communication ports by using APICOM or the analyzer's standard serial data protocol.

REPORT PERIOD: Sets how often the sample readings stored in volatile memory are processed, (e.g. average, minimum or maximum are calculated) and the results stored permanently in the instruments Disk-on-Chip as well as transmitted via the analyzer's communication ports. The Report Period may be set from the front panel. If the INST sample mode is selected the instrument stores and reports an instantaneous reading of the selected parameter at the end of the chosen report period.

To define the **REPORT PERIOD**, follow the instruction shown in Section 7.1.5 then press:



The **SAMPLE PERIOD** and **REPORT PERIOD** intervals are synchronized to the beginning and end of the appropriate interval of the instruments internal clock.

If **SAMPLE PERIOD** were set for one minute the first reading would occur at the beginning of the next full minute according to the instrument's internal clock.

If the **REPORT PERIOD** were set for of one hour, the first report activity would occur at the beginning of the next full hour according to the instrument's internal clock.

EXAMPLE:

Given the above settings, if the iDAS were activated at 7:57:35 the first sample would occur at 7:58 and the first report would be calculated at 8:00 consisting of data points for 7:58, 7:59 and 8:00.

During the next hour (from 8:01 to 9:00), the instrument will take a sample reading every minute and include 60 sample readings.

NOTE

In AVG, SDEV, MIN or MAX sample modes (see Section 7.1.5.3), the settings for the Sample Period and the Report Period determine the number of data points used each time the parameter is calculated, stored and reported to the COMM ports.

The actual sample readings are not stored past the end of the chosen report period.

When the STORE NUM SAMPLES feature is turned on, the instrument will store how many measurements were used to compute the AVG, SDEV, MIN or MAX Value, but not the actual measurements themselves.

7.1.5.5. **Report Periods in Progress When Instrument Is Powered Off**

If the instrument is powered off in the middle of a **REPORT PERIOD**, the samples accumulated so far during that period are lost. Once the instrument is turned back on, the iDAS restarts taking samples and temporarily stores them in volatile memory as part of the **REPORT PERIOD** currently active at the time of restart. At the end of this **REPORT PERIOD PERIOD,** only the sample readings taken since the instrument was turned back on will be included in any **AVG**, **SDEV**, **MIN** or **MAX** calculation.

Also, the **STORE NUM SAMPLES** feature will report the number of sample readings taken since the instrument was restarted.

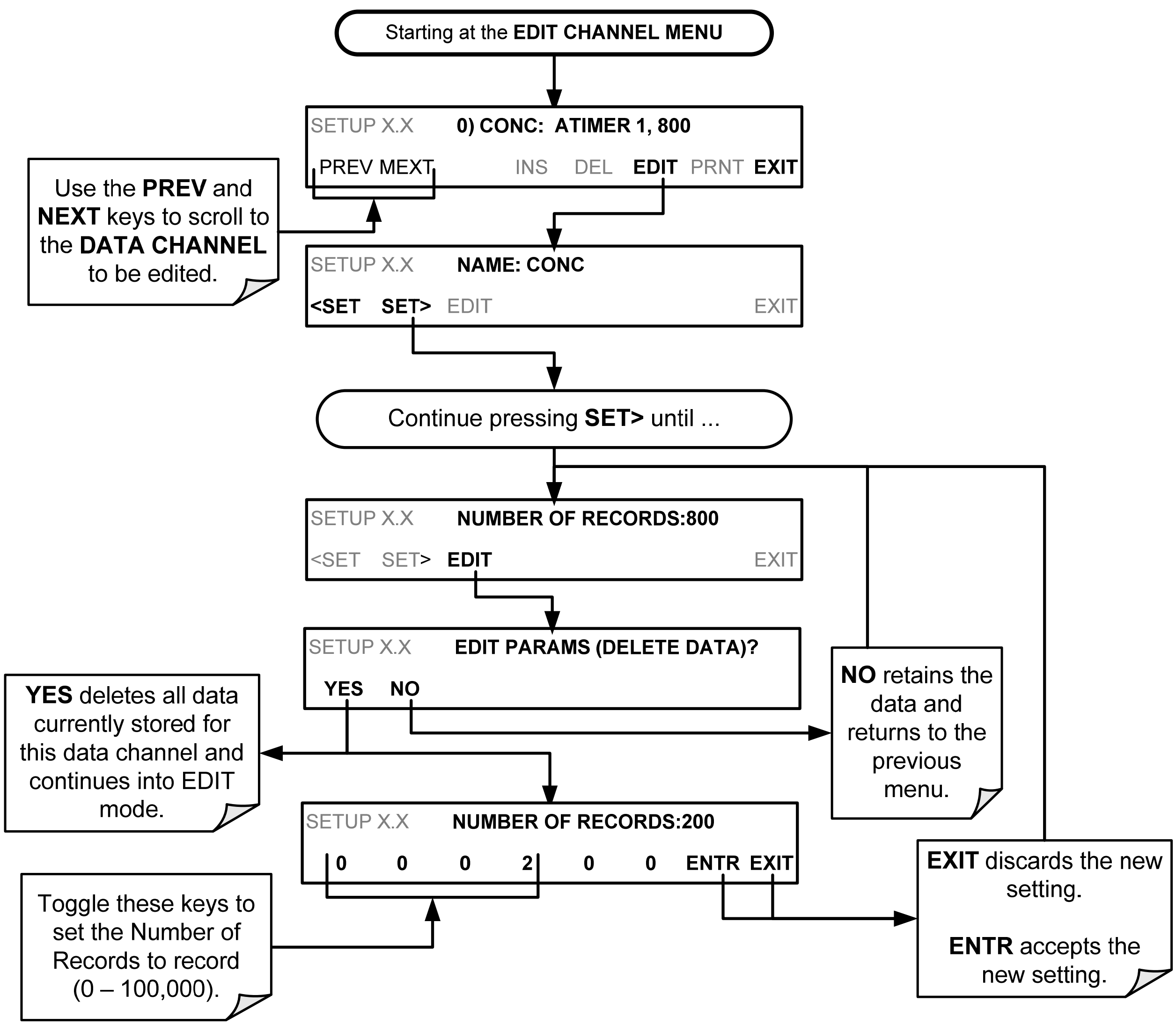
7.1.5.6. **Editing the Number of Records**

The number of data records in the iDAS is limited to about a cumulative one million data points in all channels (one megabyte of space on the Disk-on-Chip). However, the actual number of records is also limited by the total number of parameters and channels and other settings in the iDAS configuration. Every additional data channel, parameter, number of samples setting, etc., will reduce the maximum amount of data points. In general, however, the maximum data capacity is divided amongst all channels (max: 20) and parameters (max: 50 per channel).

The iDAS will check the amount of available data space and prevent the user from specifying too many records at any given point. If, for example, the iDAS memory space can accommodate 375 more data records, the **ENTR** key will disappear when trying to specify more than that number of records. This check for memory space may also cause the upload of an iDAS configuration with APICOM or a terminal program to fail, if the combined number of records would be exceeded. In this case, it is suggested to either try to determine what the maximum number of records available is using the front panel interface or use trial-and-error in designing the iDAS script or calculate the number of records using the DAS or APICOM manuals.

To set the **NUMBER OF RECORDS**, follow the instruction shown in Section 7.1.5 then press:

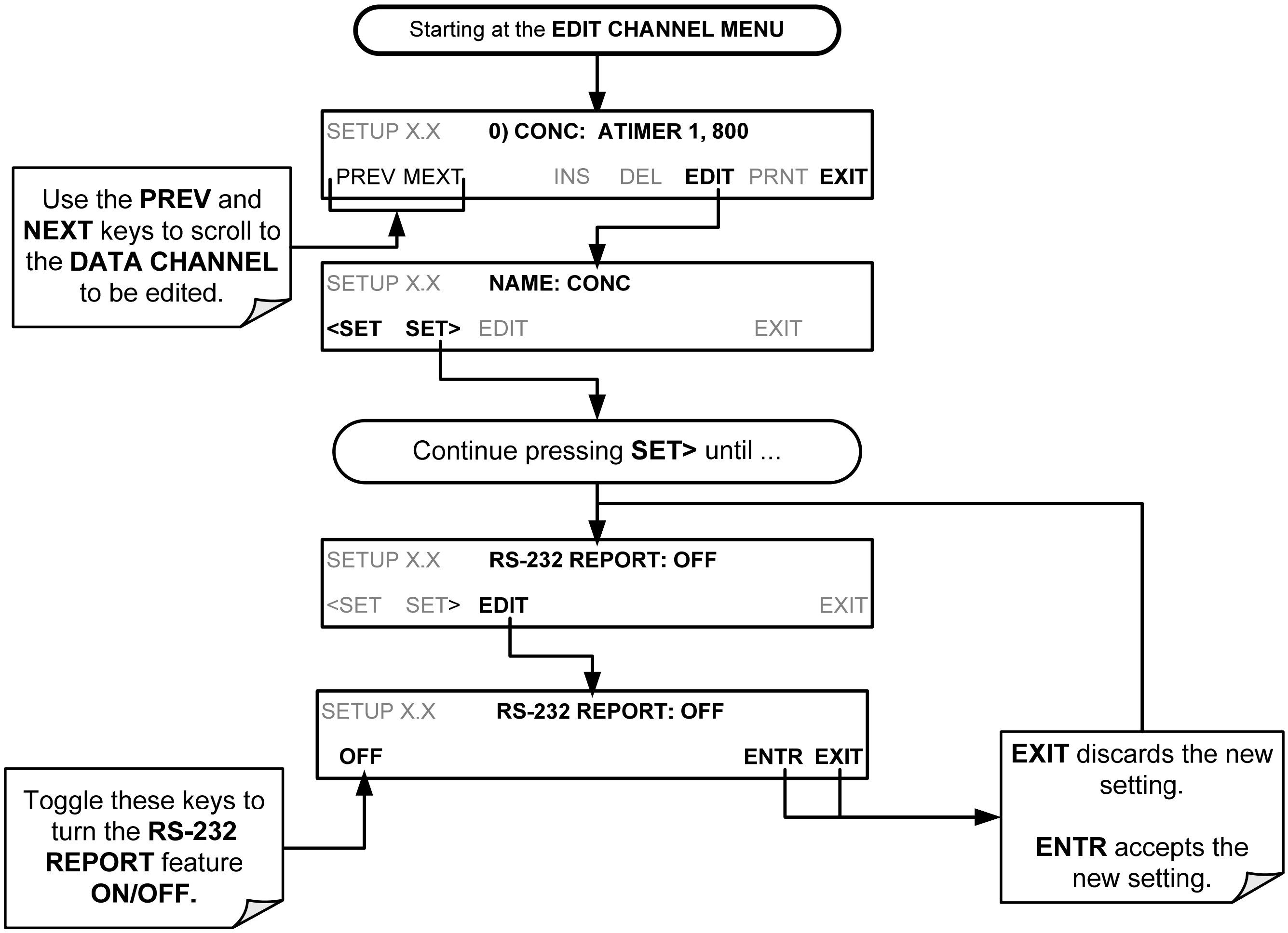
.



7.1.5.7. RS-232 Report Function

The iDAS can automatically report data to the communications ports, where they can be captured with a terminal emulation program or simply viewed by the user using the APICOM software.

To enable automatic **COMM** port reporting, follow the instruction shown in Section 7.1.5 then press:

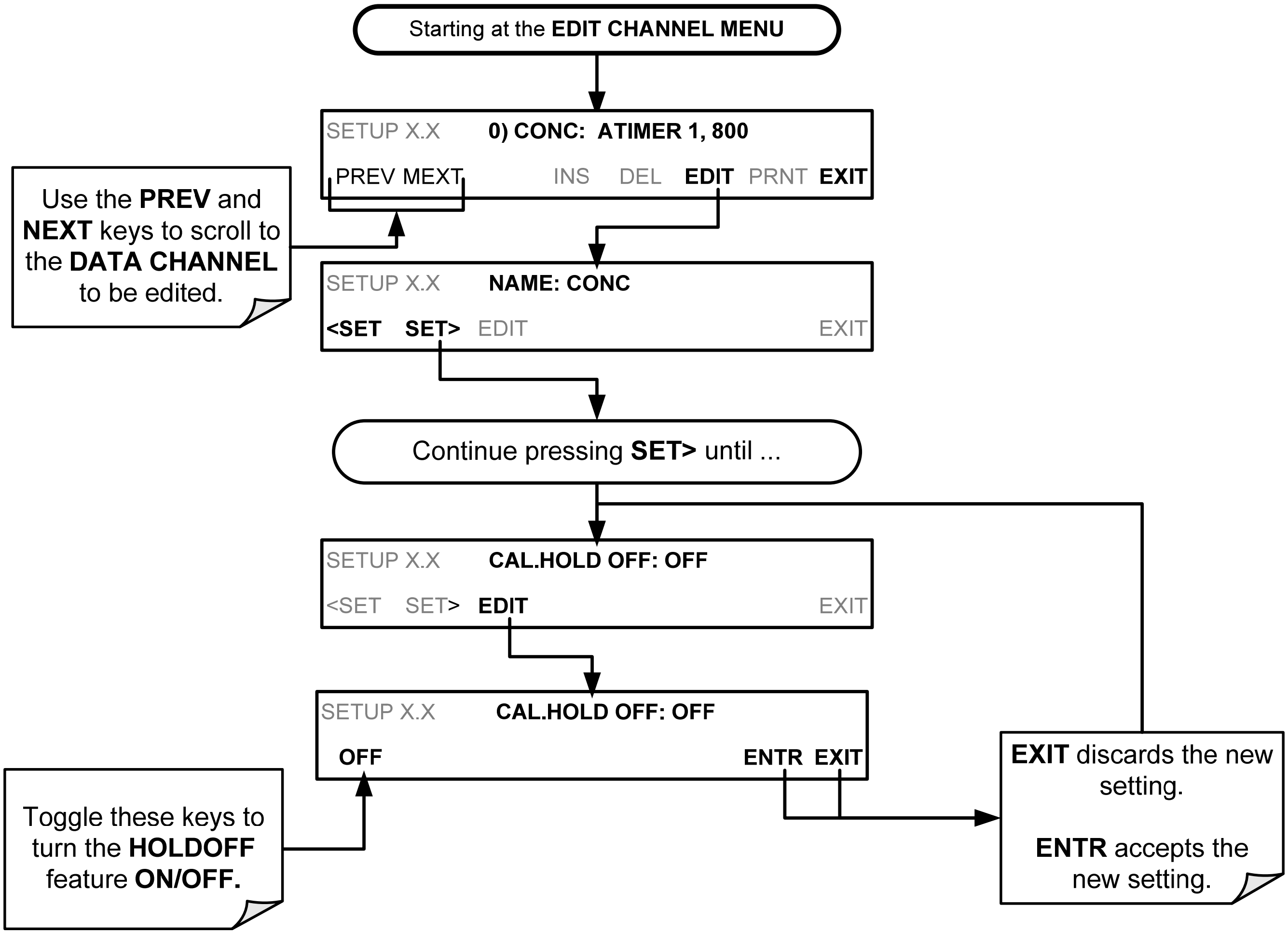


7.1.5.8. **Enabling/Disabling the HOLDOFF Feature**

The iDAS **HOLDOFF** feature prevents data collection during calibration operations and at certain times when the quality of the analyzer's CO measurements may not be certain (e.g. while the instrument is warming up). In this case, the length of time that the **HOLDOFF** feature is active is determined by the value of the internal variable (**VARS**), **DAS_HOLDOFF.**

To set the length of the **DAS_HOLDOFF** period, see Section **Error! Reference source not found.**.

To enable or disable the **HOLDOFF**, follow the instruction shown in Section 7.1.5 then press:



7.1.5.9. **The Compact Report Feature**

When enabled, this option avoids unnecessary line breaks on all RS-232 reports. Instead of reporting each parameter in one channel on a separate line, up to five parameters are reported in one line.

The **COMPACT DATA REPORT** generally cannot be accessed from the standard iDAS front panel menu, but is available via the instruments communication ports by using APICOM or the analyzer's standard serial data protocol.

7.1.5.10. **The Starting Date Feature**

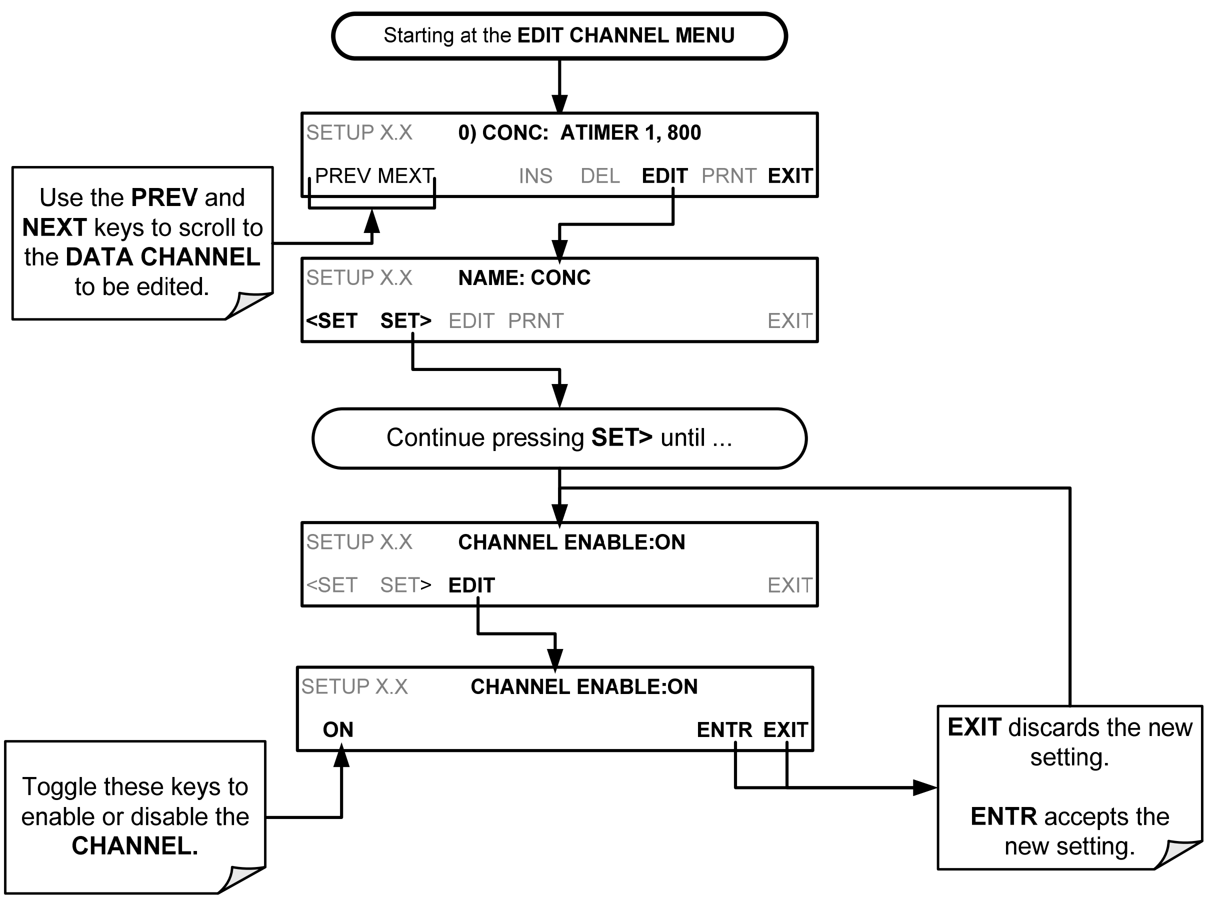
This option allows the user to specify a starting date for any given channel in case the user wants to start data acquisition only after a certain time and date. If the **STARTING DATE** is in the past (the default condition), the iDAS ignores this setting and begins recording data as defined by the **REPORT PERIOD** setting.

The **STARTING DATE** generally cannot be accessed from the standard iDAS front panel menu, but is available via the instruments communication ports by using APICOM or the analyzer's standard serial data protocol.

7.1.6. **DISABLING/ENABLING DATA CHANNELS**

Data channels can be temporarily disabled, which can reduce the read/write wear on the Disk-on-Chip.

To disable a data channel, follow the instruction shown in Section 7.1.5 then press:



7.1.7. REMOTE IDAS CONFIGURATION

7.1.7.1. iDAS Configuration Using APICOM

Editing channels, parameters and triggering events as described in this can be performed via the APICOM remote control program using the graphic interface shown below. Refer to Section 8 for details on remote access to the M300E/EM Analyzer.

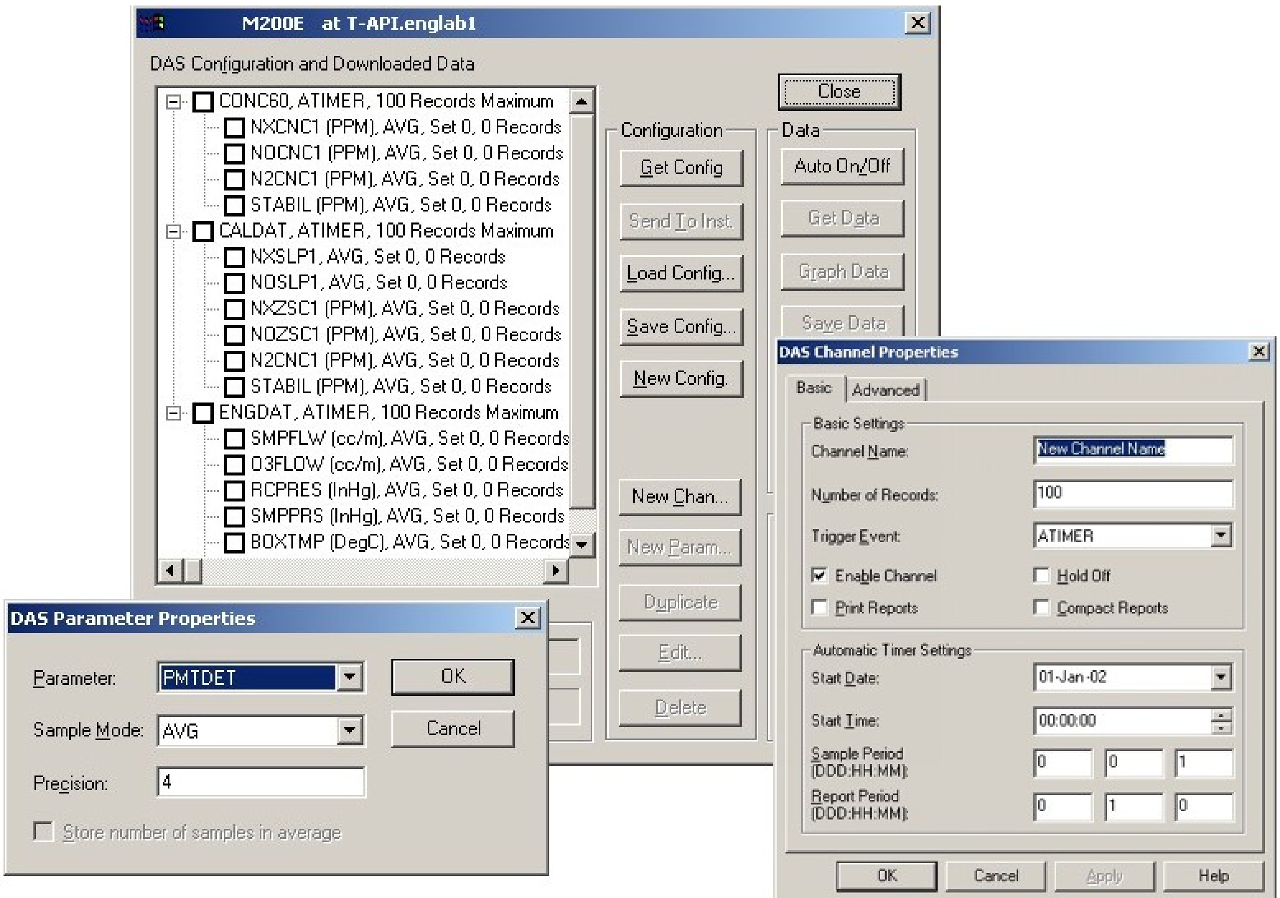


Figure 7-2: APICOM User Interface for Configuring the iDAS

Once an iDAS configuration is edited (which can be done offline and without interrupting DAS data collection), it is conveniently uploaded to the instrument and can be stored on a computer for later review, alteration or documentation and archival. Refer to the APICOM manual for details on these procedures. The APICOM user manual (Teledyne API's P/N 039450000) is included in the APICOM installation file, which can be downloaded at http://www.teledyne-api.com/manuals/.

7.1.7.2. iDAS Configuration Using Terminal Emulation Programs

Although Teledyne API recommends the use of APICOM, the iDAS can also be accessed and configured through a terminal emulation program such as HyperTerminal (see example in Figure 7-3).
To do this:

- All configuration commands must be created and edited off line (e.g. cut & pasted in from a text file or word processor) following a strict syntax (see below for example).
- The script is then uploaded via the instruments RS-232 port(s).

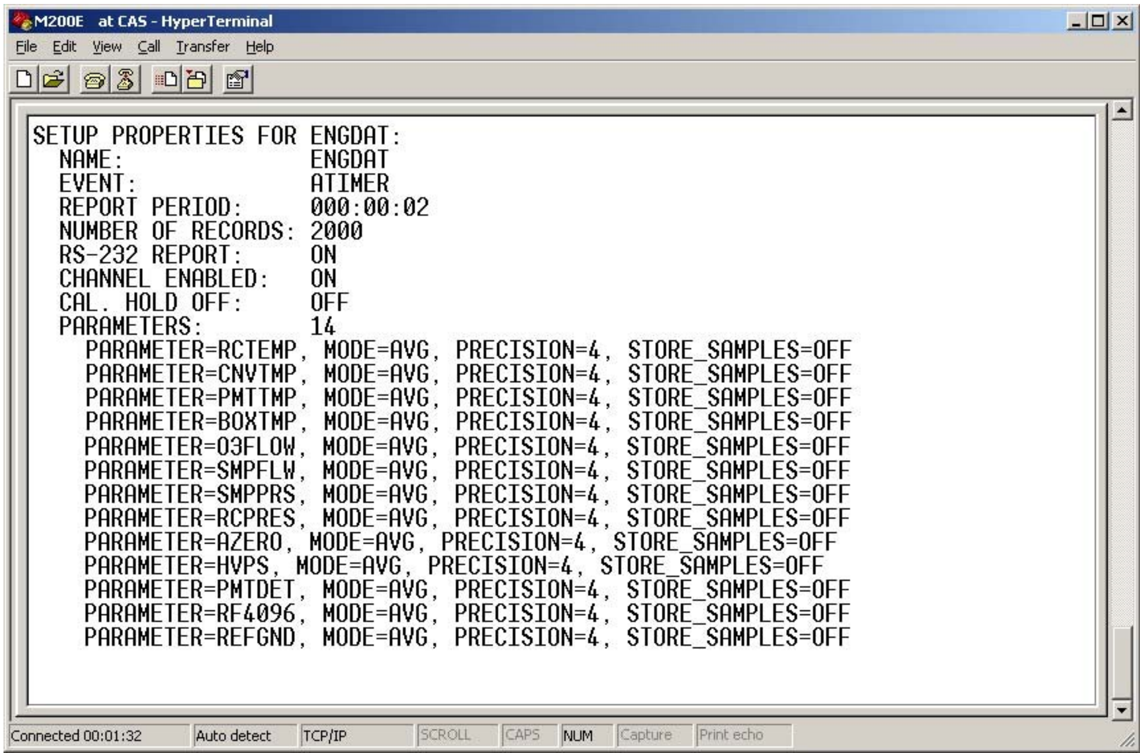


Figure 7-3: iDAS Configuration Through a Terminal Emulation Program

Both of the above steps are best started by:

1. Downloading the default iDAS configuration.
2. Getting familiar with its command structure and syntax conventions.
3. Altering a copy of the original file offline.
4. Uploading the new configuration into the analyzer.

NOTE

The editing, adding and deleting of iDAS channels and parameters of one channel through the front-panel keyboard can be done without affecting the other channels.

On the other hand, uploading an iDAS configuration script to the analyzer through its communication ports will ERASE ALL DATA, PARAMETERS AND CHANNELS and replace them with the new iDAS configuration.

It is recommended that you download and backup all data and the original iDAS configuration before attempting any iDAS changes.

Refer to the next section, 8. Remote Operation, for details on remote access to and from the M300E/EM Analyzer via the instrument's COMM ports.

7.2. SETUP → MORE → VARS: INTERNAL VARIABLES (VARS)

The M300E/EM has several user-adjustable software variables, which define certain operational parameters. Usually, these variables are automatically set by the instrument's firmware, but can be manually redefined using the **VARS** menu.

The following table lists all variables that are available within the 818 password protected level. See Appendix A-2 for a detailed listing of all of the M300E/EM variables that are accessible through the remote interface.

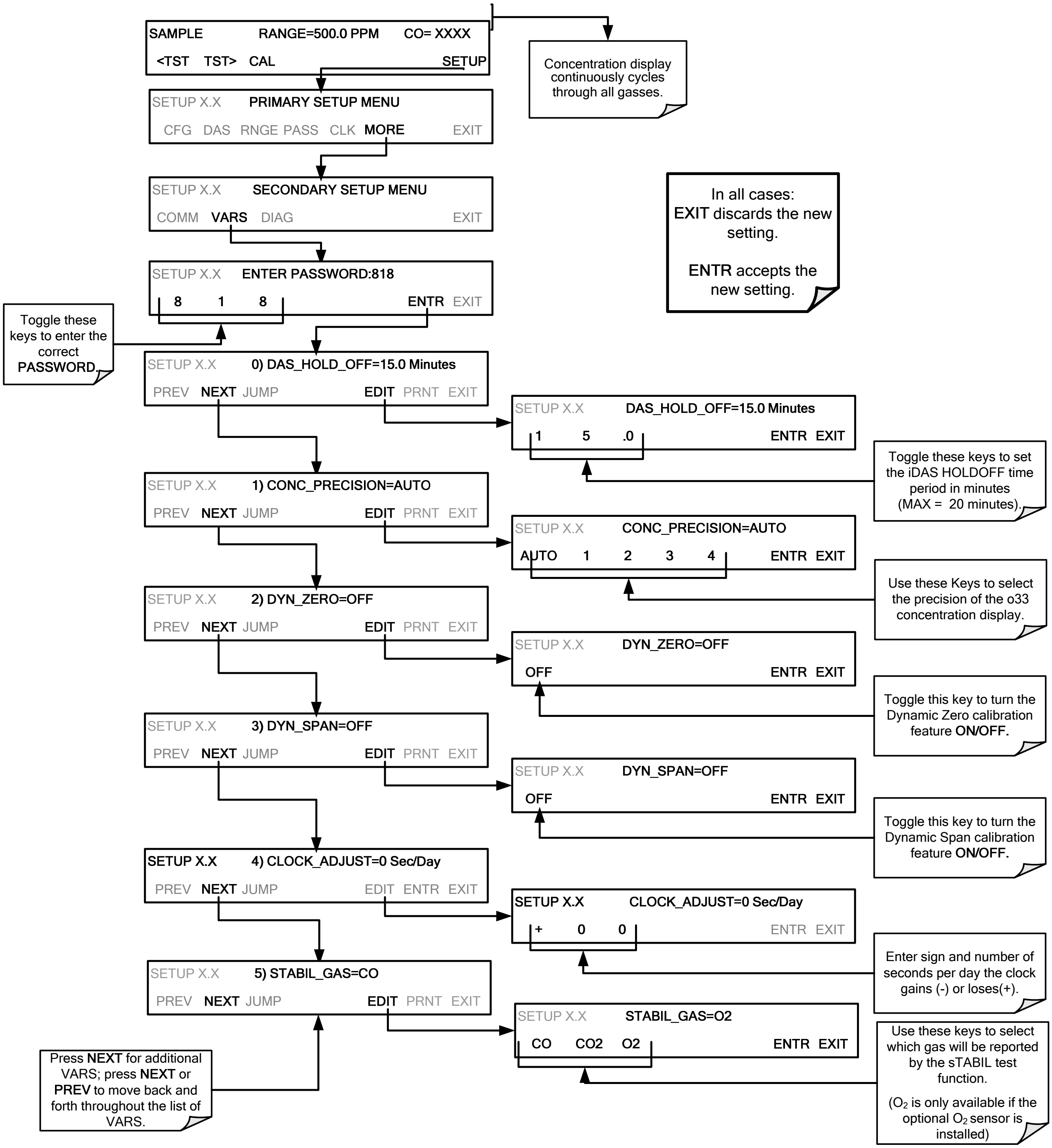
Table 7-4: Variable Names (VARS)

NO.	VARIABLE	DESCRIPTION	ALLOWED VALUES	VARS DEFAULT VALUES
0	**DAS_HOLD_OFF**	Changes the Internal Data Acquisition System (iDAS) **HOLDOFF** timer. No data is stored in the iDAS channels during situations when the software considers the data to be questionable such as during warm-up or just after the instrument returns from one of its calibration modes to **SAMPLE** Mode.	May be set for intervals between 0.5 – 20 min	**15 min.**
1	**CONC_PRECISION**	Allows the user to set the number of significant digits to the right of the decimal point display of concentration and stability values.	AUTO, 1, 2, 3, 4	**AUTO**
2	**DYN_ZERO** [1]	Dynamic zero automatically adjusts offset and slope of the CO response when performing a zero point calibration during an AutoCal (see Section 9.4).	ON/OFF	**OFF**
3	**DYN_SPAN** [1]	Dynamic span automatically adjusts the offsets and slopes of the CO response when performing a slope calibration during an AutoCal (see Section 9.4).	ON/OFF	**OFF**
4	**CLOCK_ADJ**	Adjusts the speed of the analyzer's clock. Choose the + sign if the clock is too slow, choose the - sign if the clock is too fast.	-60 to +60 s/day	**0 sec**
5	**STABIL_GAS**[2]	Selects which gas measurement is displayed when the STABIL test function is selected.	CO; CO_2 & O_2	**CO**

[1] Use of the DYN_ZERO and DYN_SPAN features are not allowed for applications requiring EPA equivalency.

[2] This VARS only appears if either the optional O_2 or CO_2 sensors are installed.

To access and navigate the **VARS** menu, use the following key sequence.



7.3. SETUP → MORE → DIAG: USING THE DIAGNOSTICS FUNCTIONS

A series of diagnostic tools is grouped together under the **SETUP→MORE→DIAG** menu, as these parameters are dependent on firmware revision (see Appendix A). These tools can be used in a variety of troubleshooting and diagnostic procedures and are referred to in many places of the maintenance and trouble-shooting sections of this manual.

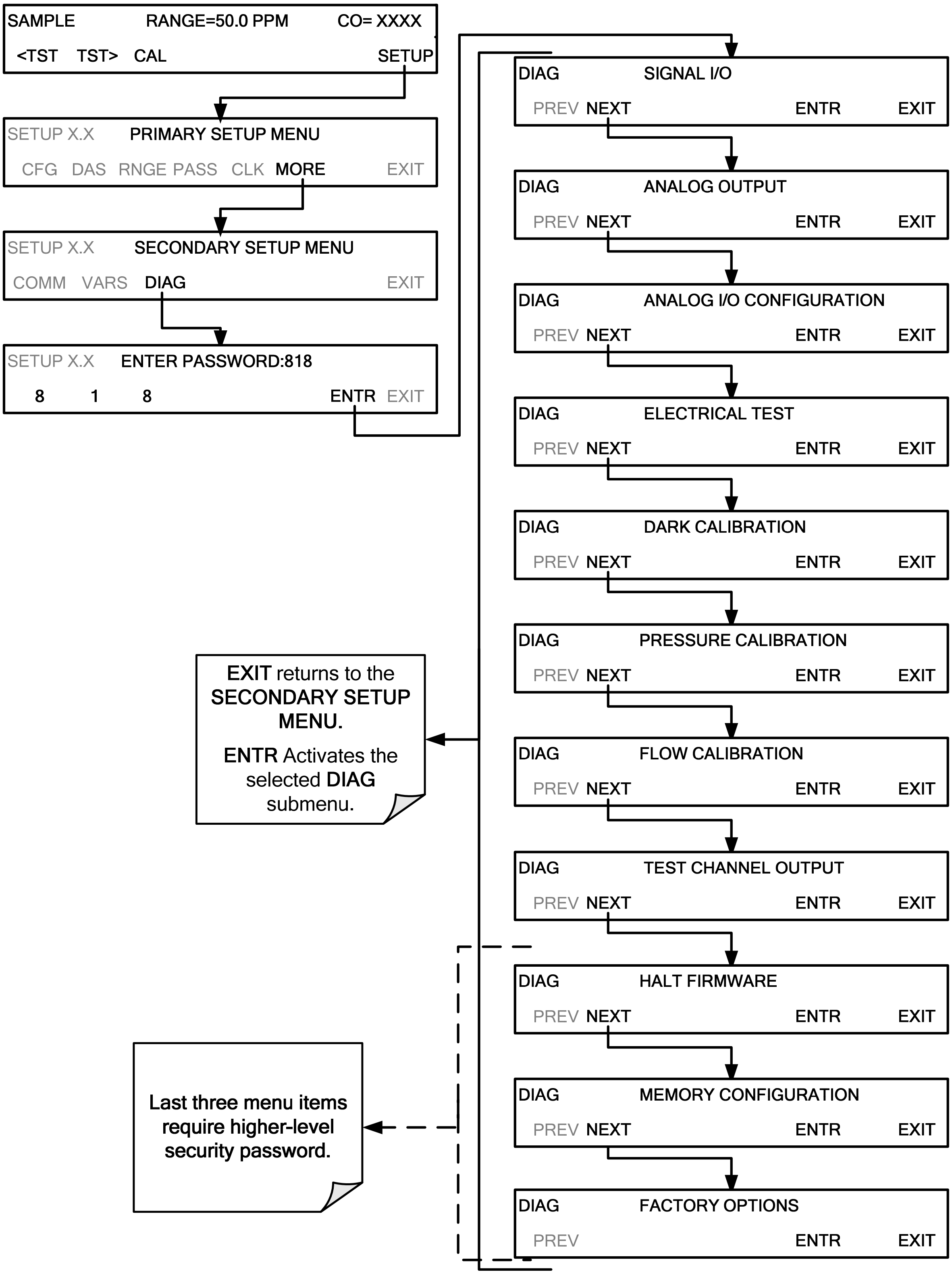
The various operating modes available under the **DIAG** menu are:

Table 7-5: Diagnostic Mode (DIAG) Functions

DIAG SUBMENU	SUBMENU FUNCTION	Front Panel Mode Indicator	MANUAL SECTION
SIGNAL I/O	Allows observation of all digital and analog signals in the instrument. Allows certain digital signals such as valves and heaters to be toggled **ON** and **OFF**.	**DIAG I/O**	13.1.3
ANALOG OUTPUT	When entered, the analyzer performs an analog output step test. This can be used to calibrate a chart recorder or to test the analog output accuracy.	**DIAG AOUT**	13.5.7.1
ANALOG I/O CONFIGURATION	This submenu allows the user to configure the analyzer's analog output channels, including choosing what parameter will be output on each channel. Instructions that appear here allow adjustment and calibration of the voltage signals associated with each output as well as calibration of the analog to digital converter circuitry on the motherboard.	**DIAG AIO**	7.4.1
ELECTRICAL TEST	When activated, the analyzer performs an electrical test, which generates a voltage intended to simulate the measure and reference outputs of the SYNC/DEMOD board to verify the signal handling and conditioning of these signals.	**DIAG ELEC**	9.6.4 13.5.6.2
DARK CALIBRATION[1]	Disconnects the preamp from synchronous demodulation circuitry on the SYNC/DEMOD PCA to establish the dark offset values for the measure and reference channel.	**DIAG DARK CAL**	9.6.1
PRESSURE CALIBRATION[1]	Allows the user to calibrate the sample pressure sensor.	**DIAG PCAL**	9.6.2
FLOW CALIBRATION[1]	This function is used to calibrate the gas flow output signals of sample gas and ozone supply.	**DIAG FCAL**	9.6.3
TEST CHAN OUTPUT	Selects one of the available test channel signals to output over the **A4** analog output channel.	**DIAG TCHN**	7.4.6
[1] These settings are retained after exiting DIAG mode.			

7.3.1. ACCESSING THE DIAGNOSTIC FEATURES

To access the **DIAG** functions press the following keys:



7.4. USING THE M300E/EM ANALYZER'S ANALOG OUTPUTS.

The M300E/EM Analyzer comes equipped with four analog outputs.

- The first two outputs (**A1 & A2)** carry analog signals that represent the currently measured concentration of CO (see Section 6.6.2).
- The third output (**A3**) is only active if the analyzer is equipped with one of the optional 2nd gas sensors (e.g. O_2 or CO_2).
- The fourth output (**A4**) outputs a signal that can be set to represent the current value of one of several test functions (see Table 7-10).

7.4.1. ACCESSING THE ANALOG OUTPUT SIGNAL CONFIGURATION SUBMENU

The following lists the analog I/O functions that are available in the M300E/EM Analyzer.

Table 7-6: DIAG - Analog I/O Functions

SUB MENU	OUTPUT CHANNEL	FUNCTION	MANUAL SECTION
AOUT CALIBRATED	**ALL**	Initiates a calibration of the **A1**, **A2**, **A3** and **A4** analog output channels that determines the slope and offset inherent in the circuitry of each output. These values are stored and applied to the output signals by the CPU automatically.	7.4.3
CONC_OUT_1	**A1**	Sets the basic electronic configuration of the **A1** output (CO Concentration). There are four options: • **RANGE**[1]: Selects the signal type (voltage or current loop) and level of the output. • **REC OFS**: Allows them input of a DC offset to let the user manually adjust the output level. • **AUTO CAL**: Enables / Disables the **AOUT CALIBRATED** feature. • **CALIBRATED**: Performs the same calibration as **AOUT CALIBRATED**, but on this one channel only.	7.4
CONC_OUT_2	**A2**	• Same as for CONC_OUT_1 but for analog channel **A2**.	
CONC_OUT_3	**A3**	• Same as for CONC_OUT_1 but for analog channel **A3** but only if either the optional O_2 or CO_2 sensors are installed.	
TEST OUTPUT	**A4**	• Same as for CONC_OUT_1 but for analog channel **A4** (TEST CHANNEL).	7.4.6
AIN CALIBRATED	**N/A**	Initiates a calibration of the A-to-D Converter circuit located on the Motherboard.	7.4.7

[1] Any changes made to **RANGE** or **REC_OFS** require recalibration of this output.

To access the **ANALOG I/O CONFIGURATION** sub menu, press:

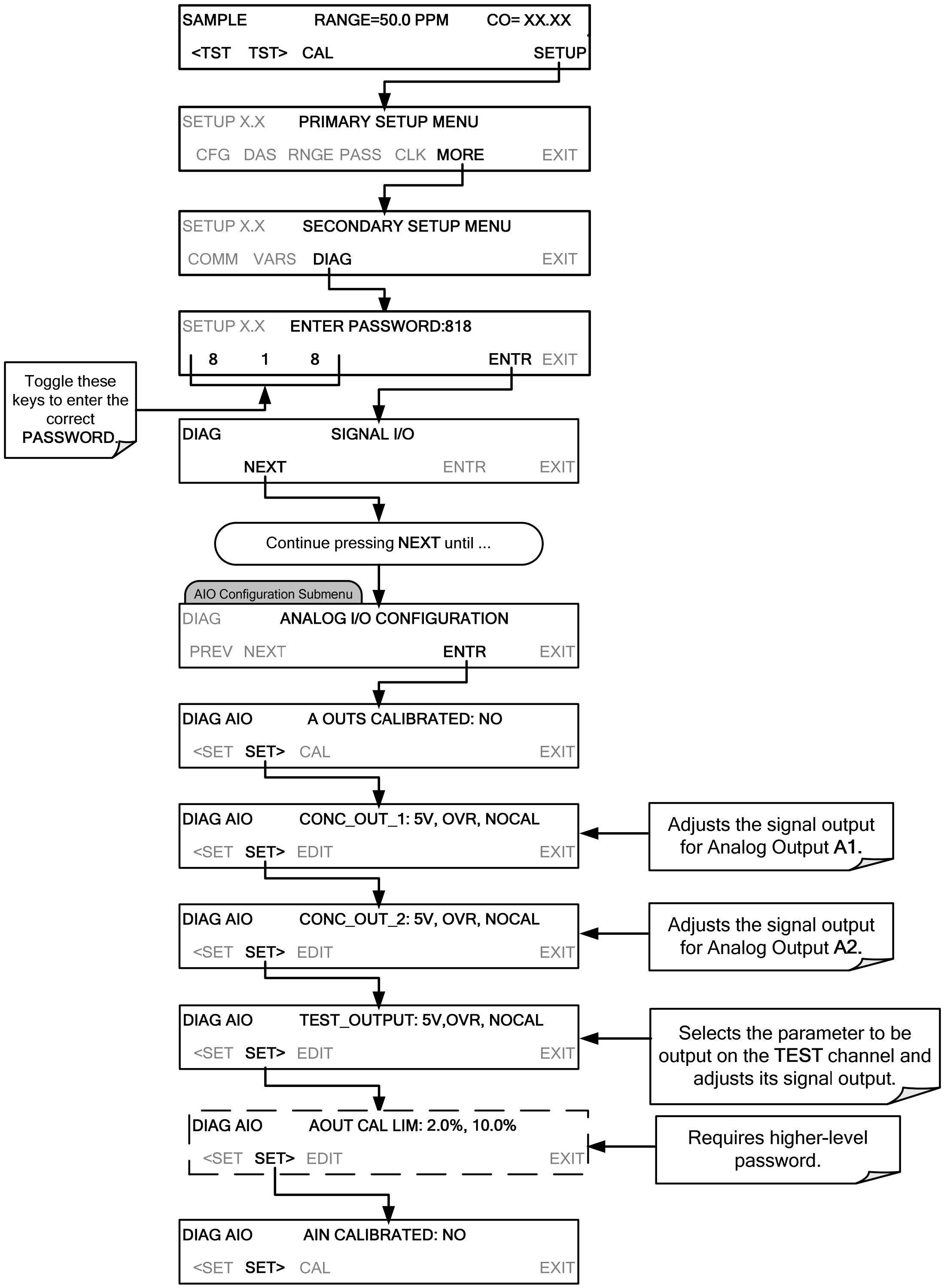


Figure 7-4: Accessing the Analog I/O Configuration Submenus

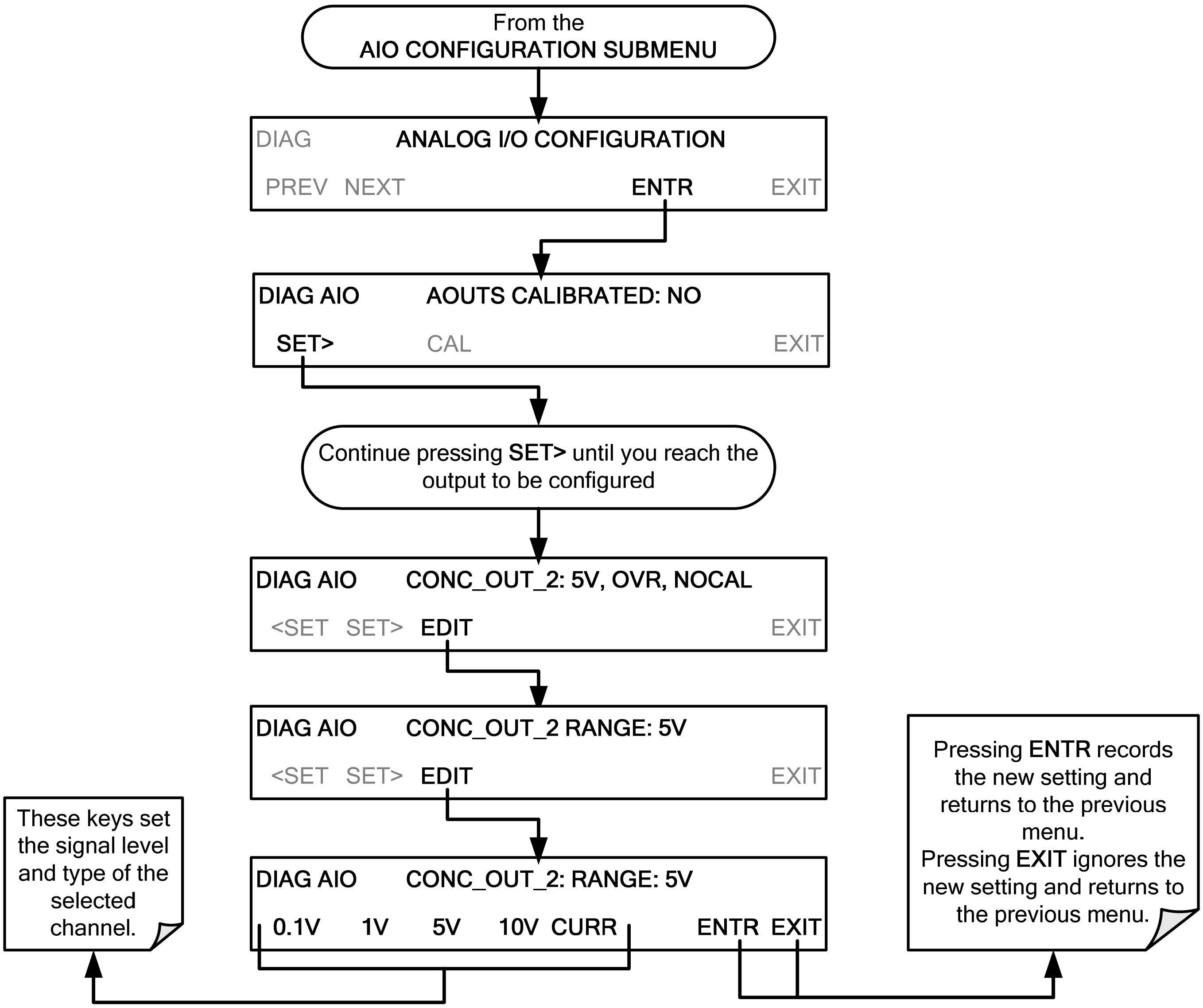
7.4.2. ANALOG OUTPUT VOLTAGE / CURRENT RANGE SELECTION

In its standard configuration, each of the analog outputs is set to output a 0–5 VDC signals. Several other output ranges are available. Each range has is usable from -5% to + 5% of the rated span.

Table 7-7: Analog Output Voltage Range Min/Max

RANGE NAME	RANGE SPAN	MINIMUM OUTPUT	MAXIMUM OUTPUT
0.1V	0-100 mVDC	-5 mVDC	105 mVDC
1V	0-1 VDC	-0.05 VDC	1.05 VDC
5V	0-5 VDC	-0.25 VDC	5.25 VDC
10V	0-10 VDC	-0.5 VDC	10.5 VDC
• The default offset for all VDC ranges is 0-5 VDC.			
CURR	0-20 mA	0 mA	20 mA
• While these are the physical limits of the current loop modules, typical applications use 2-20 or 4-20 mA for the lower and upper limits. Please specify desired range when ordering this option. • The default offset for all current ranges is 0 mA. • Current outputs are available only on A1-A3.			

To change the output type and range, select the **ANALOG I/O CONFIGURATION** submenu (see Figure 7-4) then press:



7.4.3. CALIBRATION OF THE ANALOG OUTPUTS

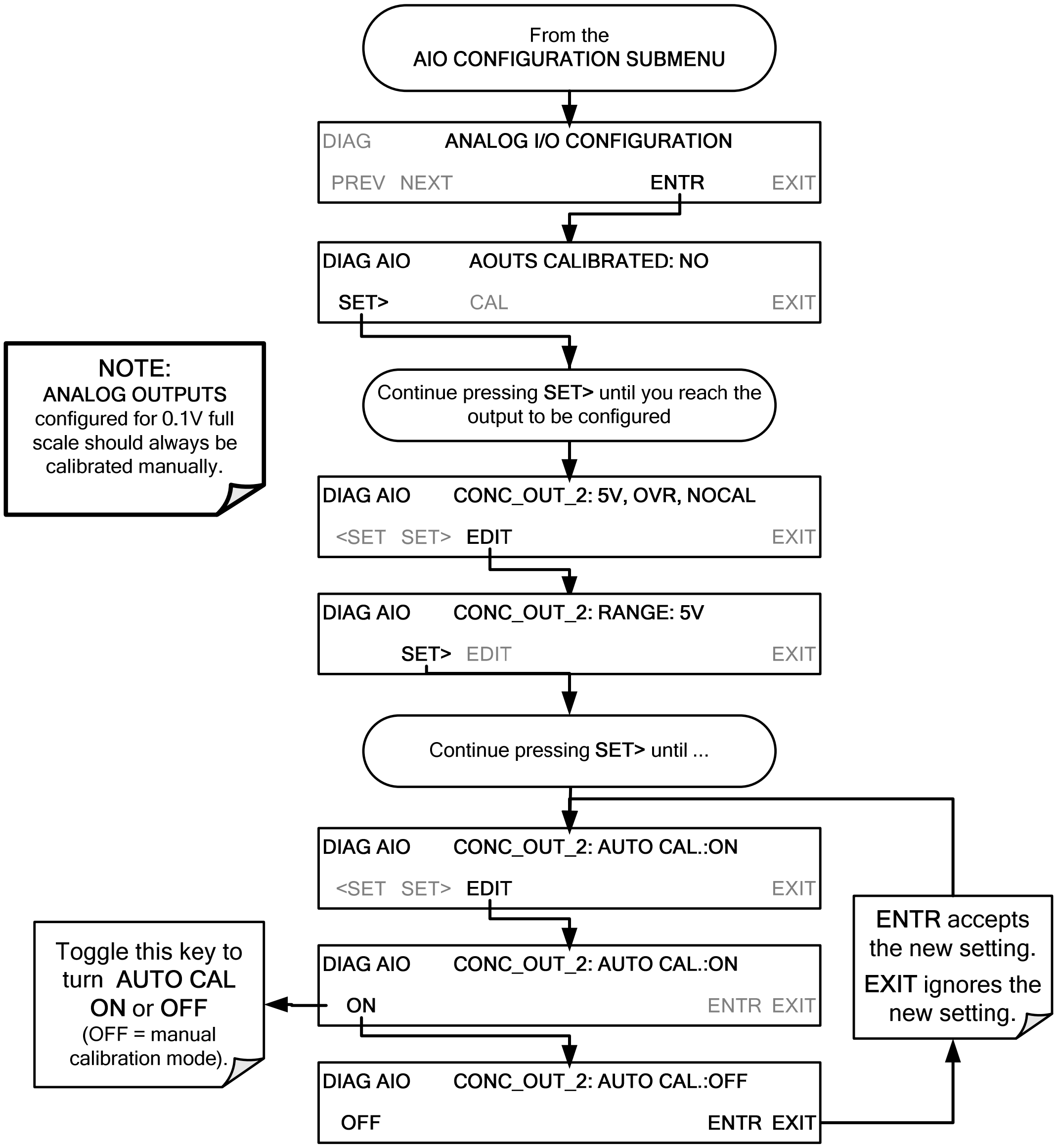
Analog output calibration should to be carried out on first startup of the analyzer (performed in the factory as part of the configuration process) or whenever recalibration is required. The analog outputs can be calibrated automatically or adjusted manually.

During automatic calibration, the analyzer tells the output circuitry to generate a zero mV signal and high-scale point signal (usually about 90% of chosen analog signal scale) then measures actual signal of the output. Any error at zero or high-scale is corrected with a slope and offset.

Automatic calibration can be performed via the **CAL** button located inside The **AOUTS CALIBRATION** submenu. By default, the analyzer is configured so that calibration of analog outputs can be initiated as a group with the **AOUT CALIBRATION** command. The outputs can also be calibrated individually, but this requires the AUTOCAL feature be disabled.

7.4.3.1. Enabling or Disabling the AutoCal for an Individual Analog Output

To enable or disable the **AutoCal** feature for an individual analog output, elect the **ANALOG I/O CONFIGURATION** submenu (see Figure 7-4) then press:

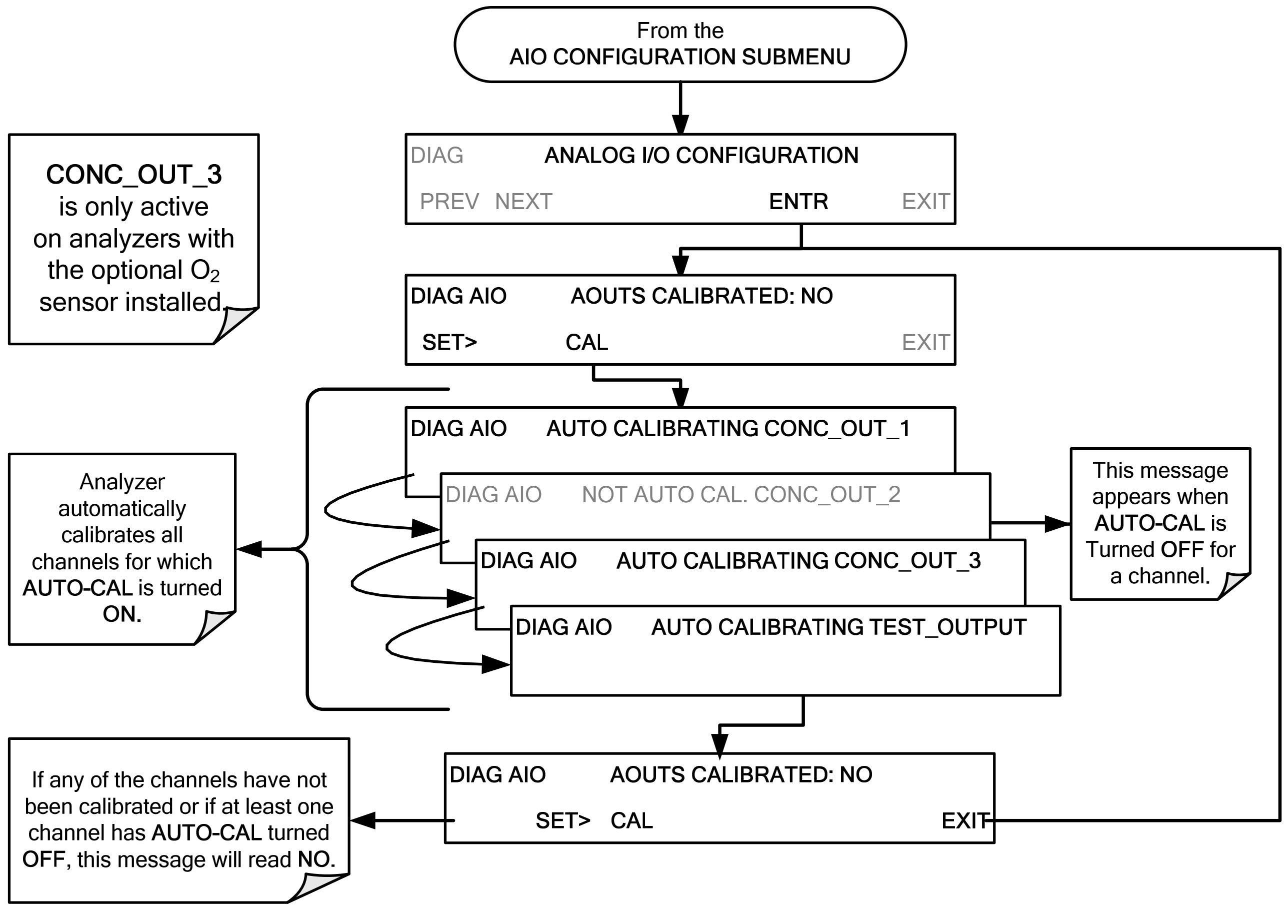


7.4.3.2. **Automatic Calibration of the Analog Outputs**

To calibrate the outputs as a group with the **AOUTS CALIBRATION** command, select the **ANALOG I/O CONFIGURATION** submenu (see Figure 7-4) then press:

NOTE

Before performing this procedure, make sure that the AUTO CAL for each analog output is enabled. (See Section 7.4.3.1)

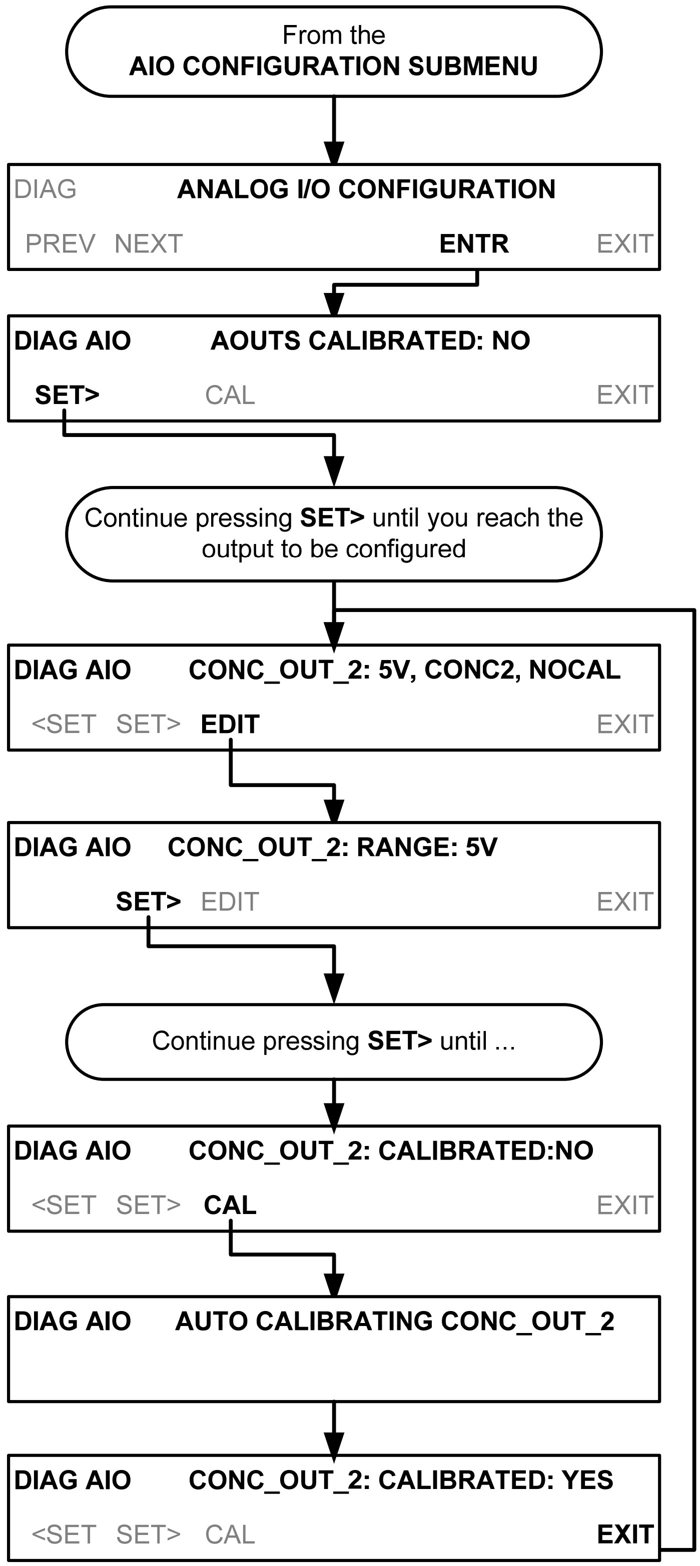


NOTE:

Manual calibration should be used for any analog output set for a 0.1V output range or in cases where the outputs must be closely matched to the characteristics of the recording device.

7.4.3.3. **Individual Calibration of the Analog Outputs**

To use the **AUTO CAL** feature to initiate an automatic calibration for an individual analog output, select the **ANALOG I/O CONFIGURATION** submenu (see Figure 7-4) then press:



7.4.3.4. **Manual Calibration of the Analog Outputs Configured for Voltage Ranges**

For highest accuracy, the voltages of the analog outputs can be manually calibrated.

> **NOTE:**
> **The menu for manually adjusting the analog output signal level will only appear if the AUTO-CAL feature is turned off for the channel being adjusted (see Section 7.4.3.1).**

Calibration is performed with a voltmeter connected across the output terminals and by changing the actual output signal level using the front panel keys in 100, 10 or 1 count increments. See Figure 3-7 for pin assignments and diagram of the analog output connector.

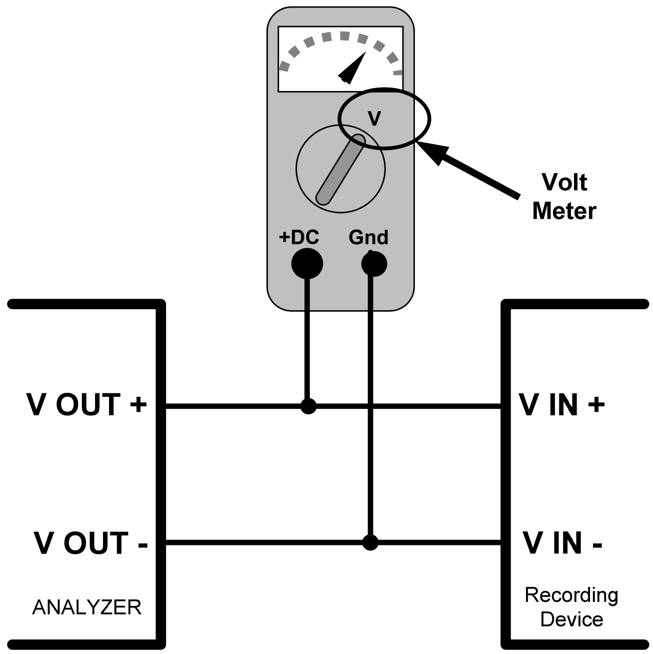
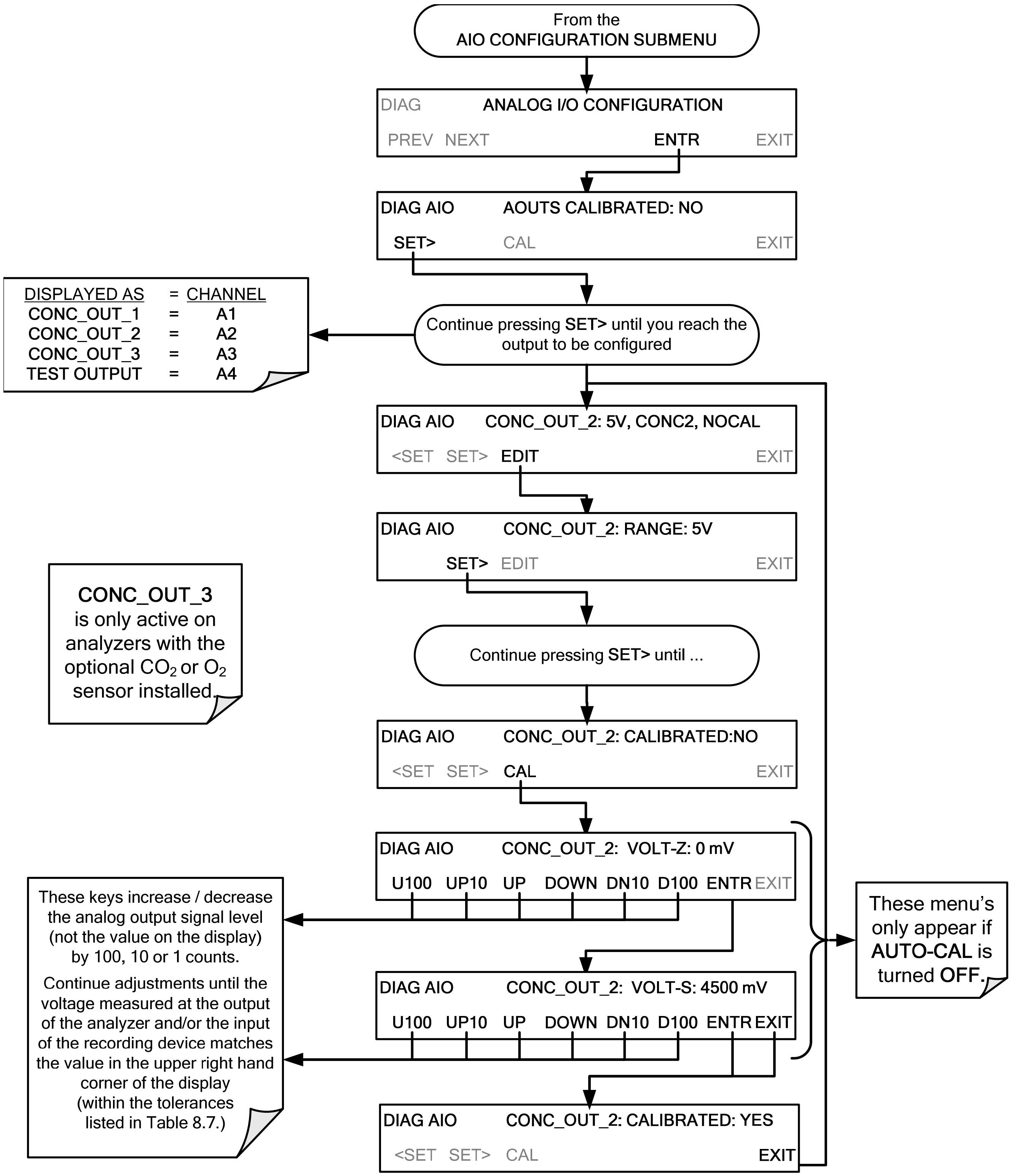


Figure 7-5: Setup for Checking / Calibrating DCV Analog Output Signal Levels

Table 7-8: Voltage Tolerances for the TEST CHANNEL Calibration

FULL SCALE	**ZERO TOLERANCE**	**SPAN VOLTAGE**	**SPAN TOLERANCE**	**MINIMUM ADJUSTMENT** (1 count)
0.1 VDC	±0.0005V	90 mV	±0.001V	0.02 mV
1 VDC	±0.001V	900 mV	±0.001V	0.24 mV
5 VDC	±0.002V	4500 mV	±0.003V	1.22 mV
10 VDC	±0.004V	4500 mV	±0.006V	2.44 mV

To adjust the signal levels of an analog output channel manually, select the **ANALOG I/O CONFIGURATION** submenu (see Figure 7-4) then press:



7.4.3.5. **Manual Adjustment of Current Loop Output Span and Offset**

A current loop option may be purchased for the **A1**, **A2** and **A3** analog outputs of the analyzer. This option places circuitry in series with the output of the D-to-A converter on the motherboard that changes the normal DC voltage output to a 0-20 milliamp signal (see Section 5.4).

- The outputs can be ordered scaled to any set of limits within that 0-20 mA range, however most current loop applications call for either 0-20 mA or 4-20 mA range spans.
- All current loop outputs have a +5% over range. Ranges whose lower limit is set above 1 mA also have a –5% under range.

To switch an analog output from voltage to current loop, follow the instructions in Section 7.4.2 (select **CURR** from the list of options on the “Output Range” menu).

Adjusting the signal zero and span levels of the current loop output is done by raising or lowering the voltage output of the D-to-A converter circuitry on the analyzer’s motherboard. This raises or lowers the signal level produced by the current loop option circuitry.

The software allows this adjustment to be made in 100, 10 or 1 count increments. Since the exact amount by which the current signal is changed per D-to-A count varies from output-to-output and instrument-to-instrument, you will need to measure the change in the signal levels with a separate, current meter placed in series with the output circuit. See Figure 3-7 for pin assignments and diagram of the analog output connector.

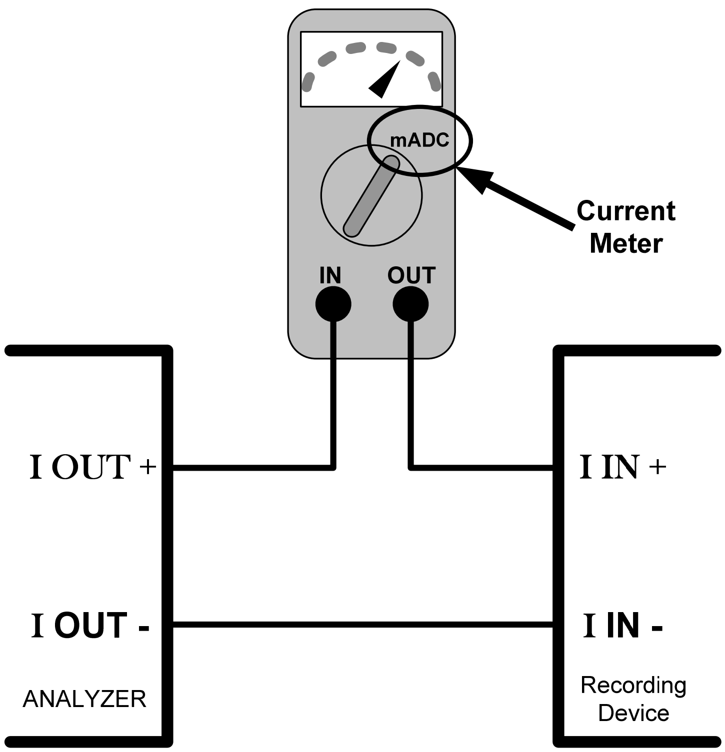


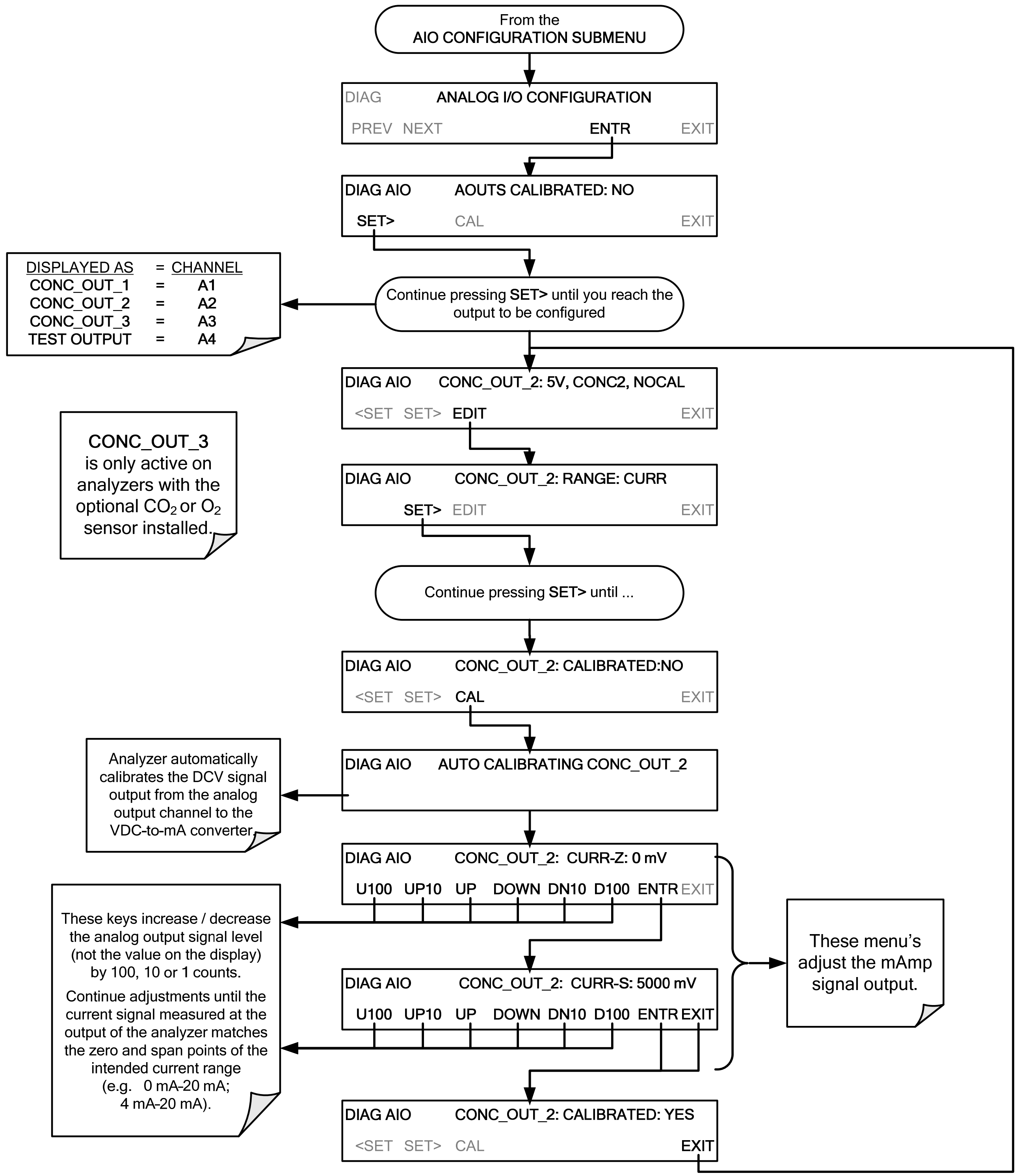
Figure 7-6: Setup for Checking / Calibration Current Output Signal Levels Using an Ammeter

CAUTION

GENERAL SAFETY HAZARD

Do not exceed 60 V peak voltage between current loop outputs and instrument ground.

To adjust the zero and span signal levels of the current outputs, select the **ANALOG I/O CONFIGURATION** submenu (see Figure 7-4) then press:



An alternative method for measuring the output of the Current Loop converter is to connect a 250 ohm ±1% resistor across the current loop output in lieu of the current meter (see Figure 3-7 for pin assignments and diagram of the analog output connector). This allows the use of a voltmeter connected across the resistor to measure converter output as VDC or mVDC.

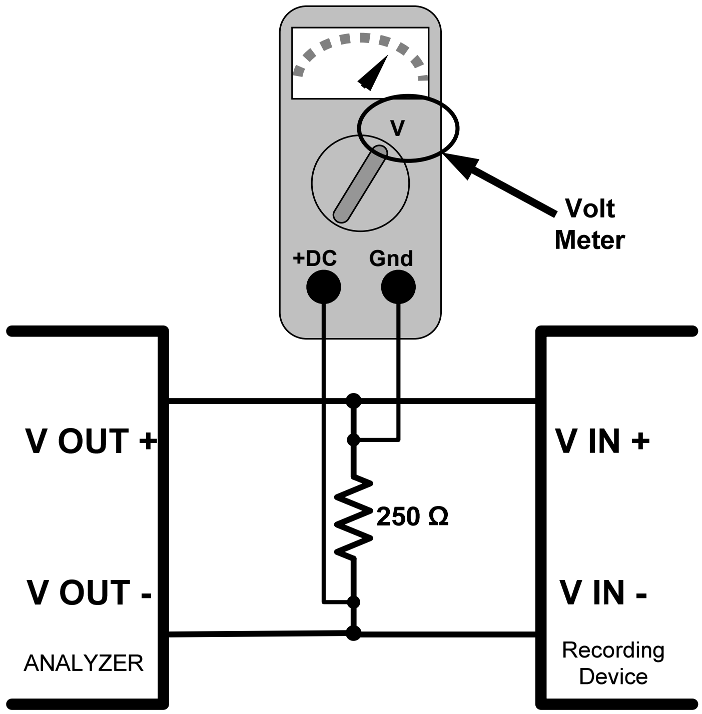


Figure 7-7: Alternative Setup Using 250Ω Resistor for Checking Current Output Signal Levels

In this case, follow the procedure above but adjust the output for the following values:

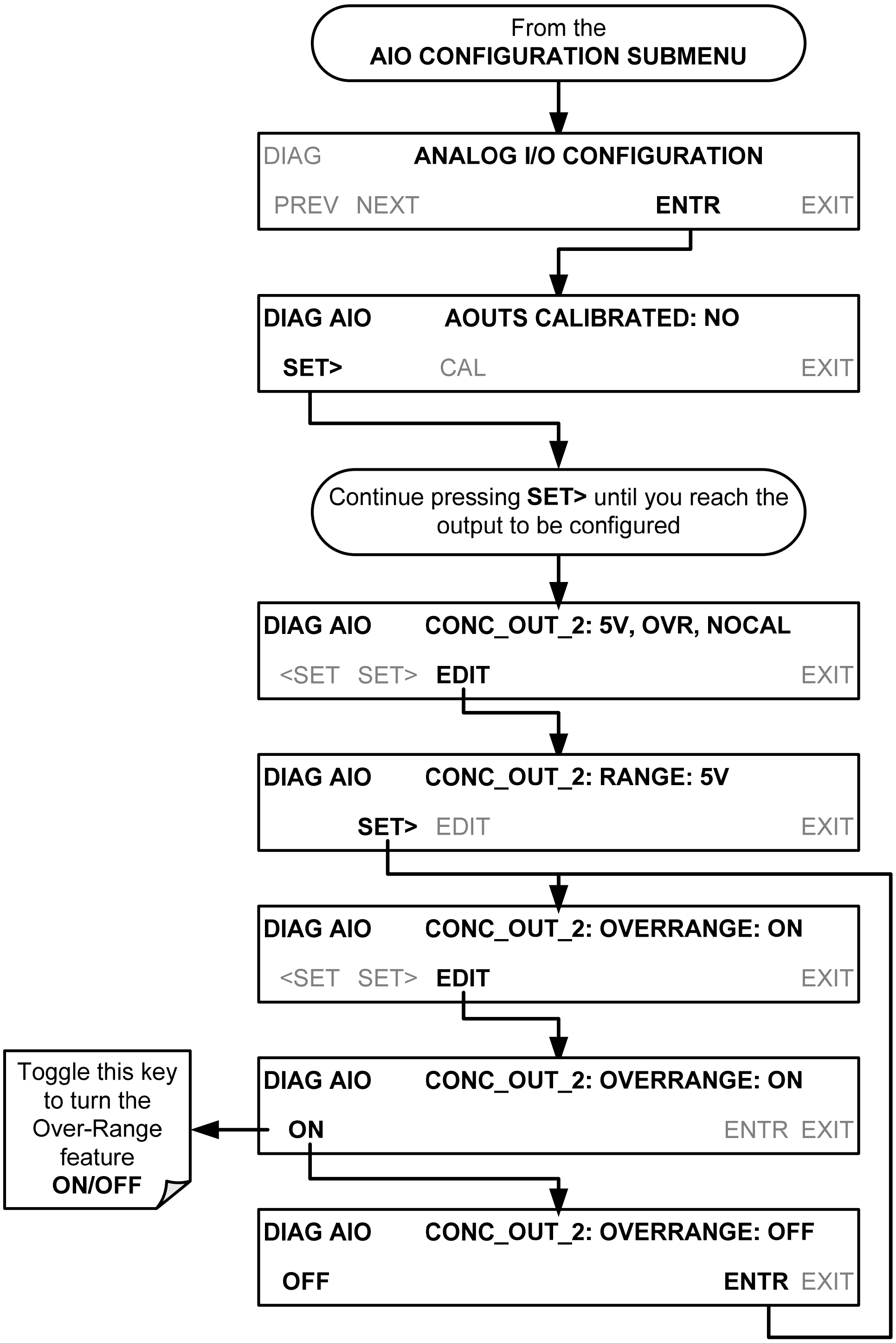
Table 7-9: Current Loop Output Check

% FS	Voltage across Resistor for 2-20 mA	Voltage across Resistor for 4-20 mA
0	500 mVDC	1000 mVDC
100	5000 mVDC	5000 mVDC

7.4.4. TURNING AN ANALOG OUTPUT OVER-RANGE FEATURE ON/OFF

In its default configuration, a ± 5% over-range is available on each of the M300E/EM Analyzer's analog outputs. This over-range can be disabled if your recording device is sensitive to excess voltage or current.

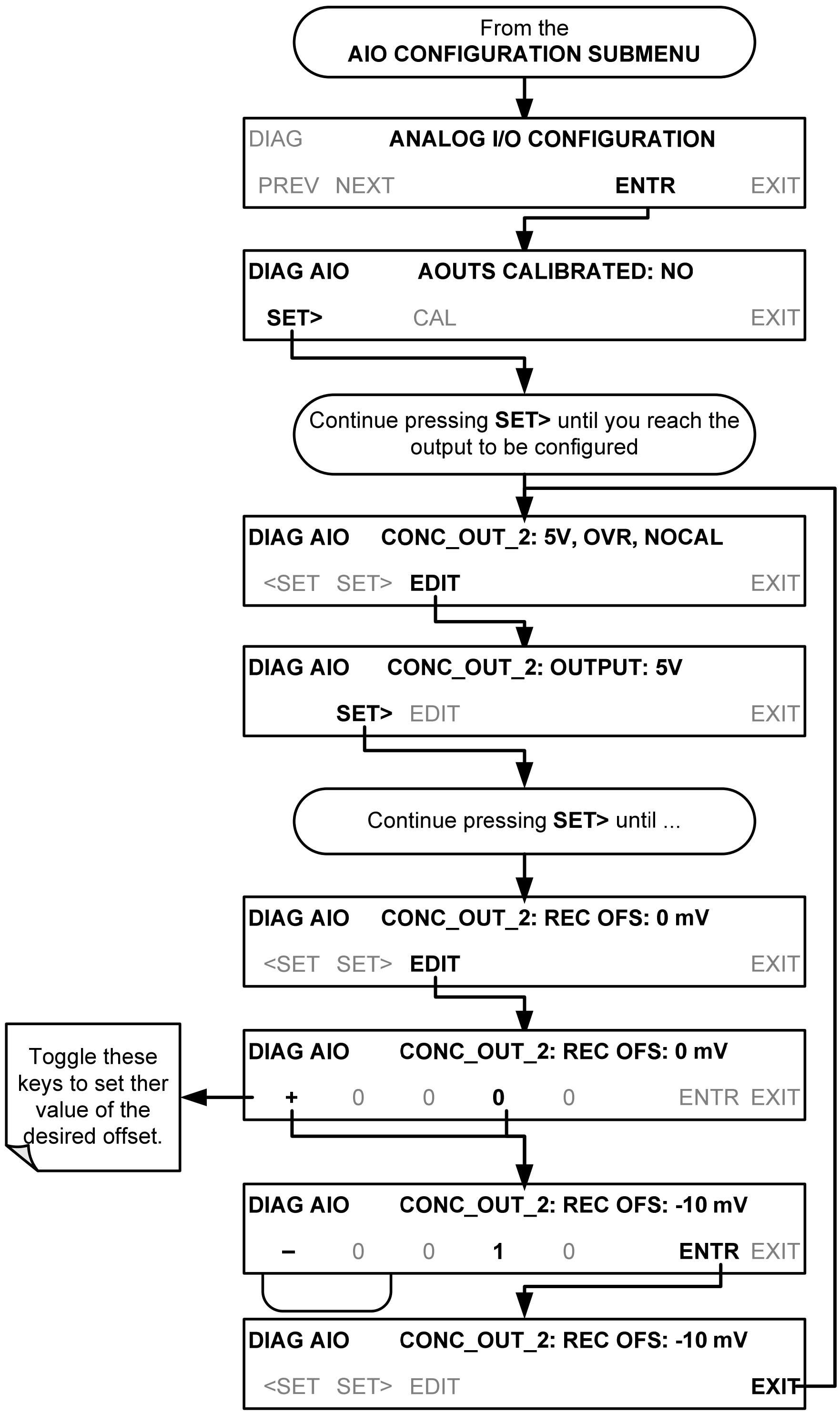
To turn the over-range feature on or off, select the **ANALOG I/O CONFIGURATION** submenu (see Figure 7-4) then press:



7.4.5. ADDING A RECORDER OFFSET TO AN ANALOG OUTPUT

Some analog signal recorders require that the zero signal is significantly different from the baseline of the recorder in order to record slightly negative readings from noise around the zero point. This can be achieved in the M300E/EM by defining a zero offset, a small voltage (e.g., 10% of span).

To add a zero offset to a specific analog output channel, select the **ANALOG I/O CONFIGURATION** submenu (see Figure 7-4) then press:



7.4.6. SELECTING A TEST CHANNEL FUNCTION FOR OUTPUT A4

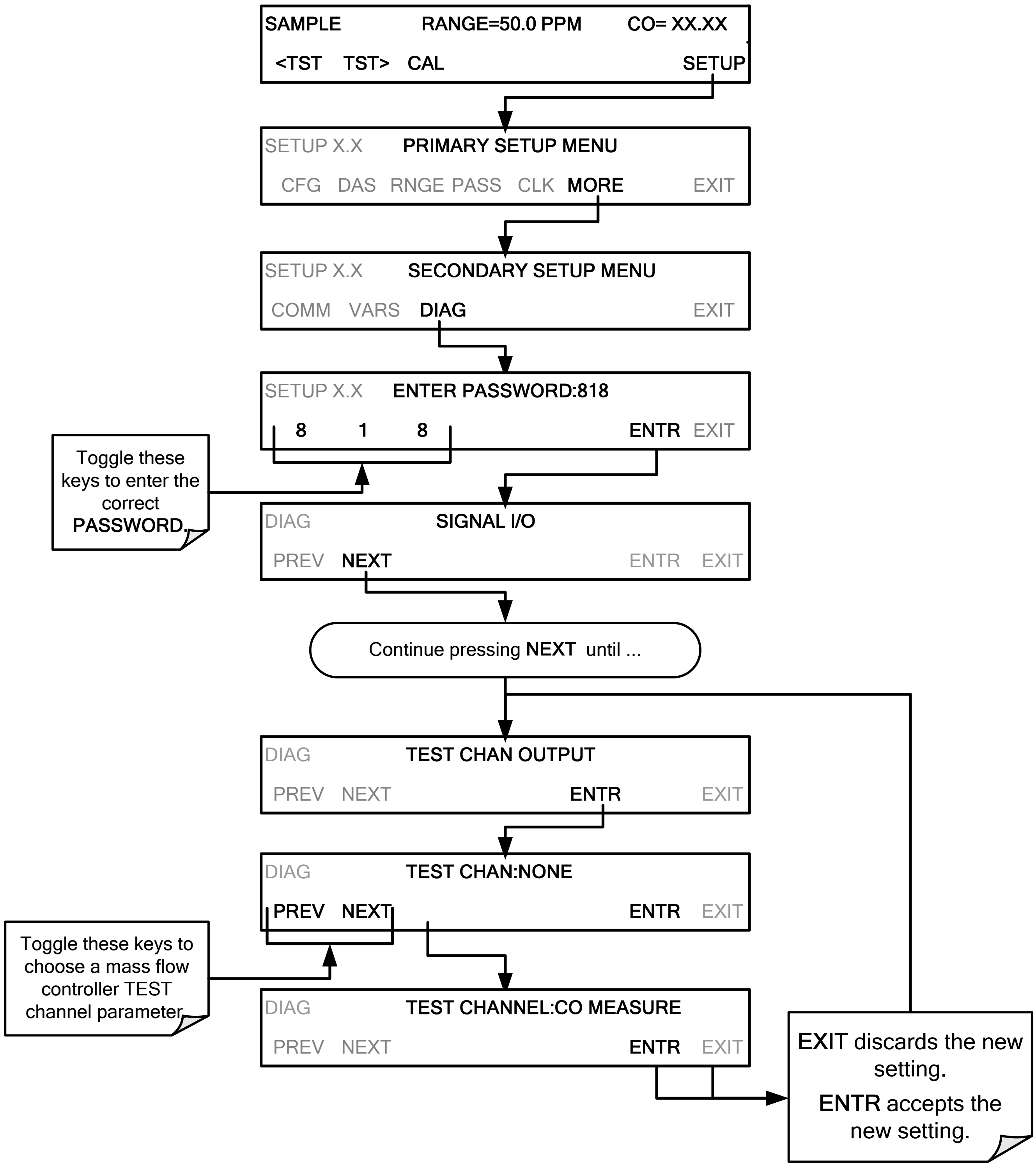
The test functions available to be reported are listed in Table 7-10:

Table 7-10: Test Channels Functions available on the M300E/EM's Analog Output

TEST CHANNEL	DESCRIPTION	ZERO	FULL SCALE *
NONE	*TEST CHANNEL IS TURNED OFF.*		
CO MEASURE	The demodulated, peak IR detector output during the measure portion of the GFC Wheel cycle.	0 mV	5000 mV
CO REFERENCE	The demodulated, peak IR detector output during the reference portion of the GFC Wheel cycle.	0 mV	5000 mV
SAMPLE PRESS	The absolute pressure of the Sample gas as measured by a pressure sensor located inside the sample chamber.	0" Hg	40 "Hg
SAMPLE FLOW	Sample mass flow rate as measured by the flow rate sensor in the sample gas stream.	0 cm^3/m	1000 cm^3/m
SAMPLE TEMP	The temperature of the gas inside the sample chamber.	0°C	70°C
BENCH TEMP	Optical bench temperature.	0°C	70°C
WHEEL TEMP	GFC Wheel temperature.	0°C	70°C
O_2 **CELL TEMP**	The current temperature of the O_2 sensor measurement cell.	n	70°C
CHASSIS TEMP	The temperature inside the analyzer chassis.	0°C	70°C
PHT DRIVE	The drive voltage being supplied to the thermoelectric coolers of the IR photo-detector by the Sync/Demod Board.	0 mV	5000 mV
* Maximum test signal value at full scale of test channel output.			

Once a function is selected, the instrument not only begins to output a signal on the analog output, but also adds **TEST** to the list of test functions viewable via the front panel display.

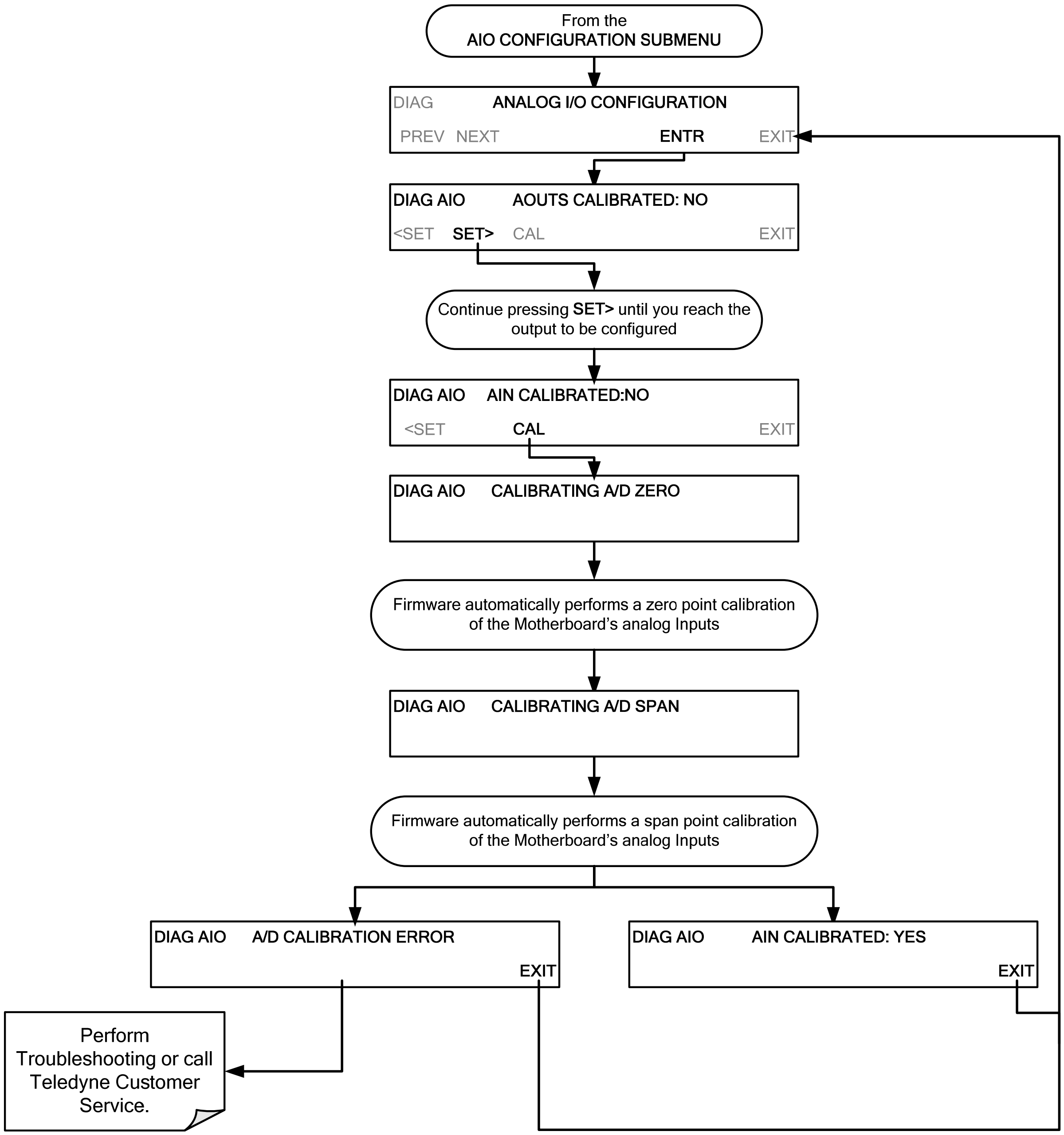
To activate the **TEST** Channel and select **CO MEASURE** a function, press:



7.4.7. **AIN CALIBRATION**

This is the submenu to conduct a calibration of the M300E/EM Analyzer's analog inputs. This calibration should only be necessary after major repair such as a replacement of CPU, motherboard or power supplies.

To perform an analog input calibration, select the **ANALOG I/O CONFIGURATION** submenu (see Figure 7-4) then press:



7.5. SETUP →MORE → ALRM: USING THE GAS CONCENTRATION ALARMS

The M300E/EM includes two CO concentration alarms if OPT 61 is installed on your instrument. Each alarm has a user settable limit, and is associated with a Single Pole Double Throw relay output accessible via the alarm output connector on the instrument's back panel (See Section 3.3.3). If the CO concentration measured by the instrument rises above that limit, the alarm's status output relay is closed.

The default settings for **ALM1** and **ALM2** are:

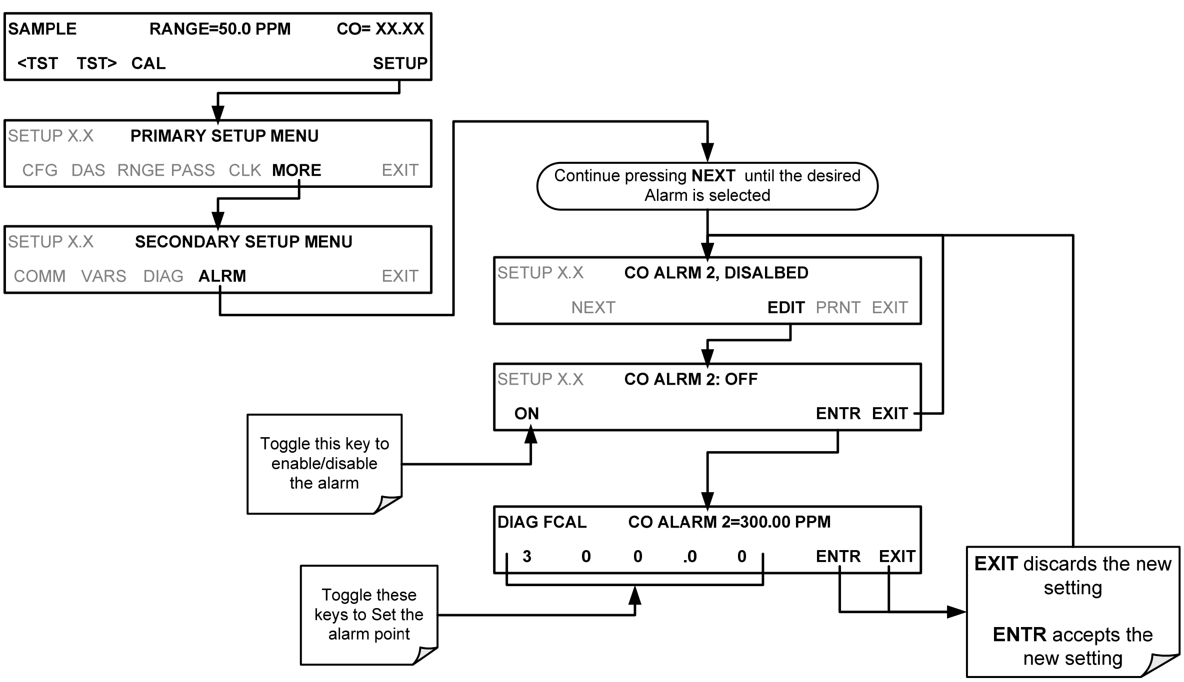
Table 7-11: CO Concentration Alarm Default Settings

ALARM	STATUS	LIMIT SET POINT[1]
alm1	Disabled	100 ppm
alm2	Disabled	300 ppm
[1]Set points listed are for PPM. Should the reporting range units of measure be changed (See Section 6.6.3) the analyzer will automatically scale the set points to match the new range unit setting.		

NOTE
To prevent the concentration alarms from activating during span calibration operations ensure that the CAL or CALS button is pressed prior to introducing span gas into the analyzer.

7.5.1. SETTING THE M300E CONCENTRATION ALARM LIMITS

To enable either of the CO concentration alarms and set the limit points, press:



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8. REMOTE OPERATION

8.1. SETUP → MORE→ COMM: USING THE ANALYSER'S COMMUNICATION PORTS

The M300E/EM is equipped with two serial communication ports located on the rear panel (see Figure 3-2). Both ports operate similarly and give the user the ability to communicate with, issue commands to, and receive data from the analyzer through an external computer system or terminal. By default, both ports operate on the RS-232 protocol.

- The **RS232** port can also be configured to operate in single or RS-232 multidrop mode (option 62; See Section 5.7.2 and 8.2).
- The **COM2** port can be configured for standard RS-232 operation, half-duplex RS-485 communication or for access via an LAN by installing the Teledyne API's Ethernet interface card (option 63; See Section 5.7.3 and 8.4).

A Code-Activated Switch (CAS), can also be used on either port to connect typically between 2 and 16 send/receive instruments (host computer(s) printers, data loggers, analyzers, monitors, calibrators, etc.) into one communications hub. Contact Teledyne API sales for more information on CAS systems.

8.1.1. RS-232 DTE AND DCE COMMUNICATION

RS-232 was developed for allowing communications between Data Terminal Equipment (DTE) and Data Communication Equipment (DCE). Basic data terminals always fall into the DTE category whereas modems are always considered DCE devices.

Electronically, the difference between the DCE and DTE is the pin assignment of the Data Receive and Data Transmit functions.

- DTE devices receive data on pin 2 and transmit data on pin 3.
- DCE devices receive data on pin 3 and transmit data on pin 2.

A switch located below the bottom DB-9 connector on the rear panel allows the user to switch between DTE (for use with data terminals) or DCE (for use with modems). Since computers can be either DTE or DCE, check your computer to determine which mode to use.

8.1.2. COMM PORT DEFAULT SETTINGS

Received from the factory, the analyzer is set up to emulate a DCE or modem, with pin 3 of the DB-9 connector designated for receiving data and pin 2 designated for sending data.

RS-232 RS-232 (fixed) DB-9 male connector.

Baud rate: 19200 bits per second (baud).

Data Bits: 8 data bits with 1 stop bit.

Parity: None.

COM2: RS-232 (configurable to RS 485), DB-9 female connector.

Baud rate:115000 bits per second (baud).

Data Bits: 8 data bits with 1 stop bit.

Parity: None.

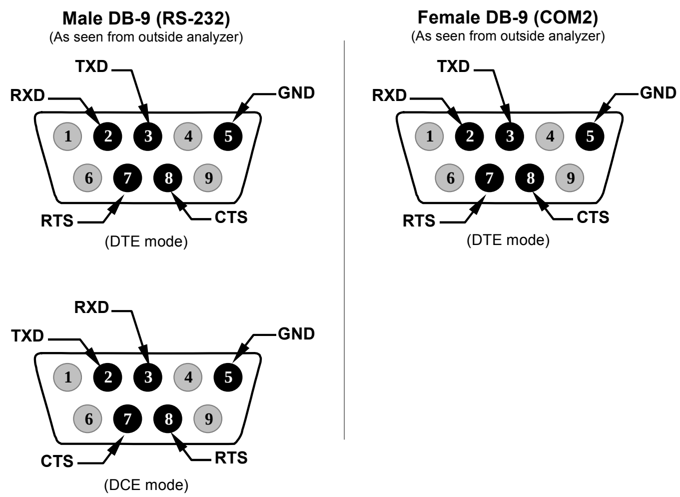


Figure 8-1: Default Pin Assignments for Back Panel COMM Port connectors (RS-232 DCE & DTE)

The signals from these two connectors are routed from the motherboard via a wiring harness to two 10-pin connectors on the CPU card, J11 (RS-232) and J12 (COM2).

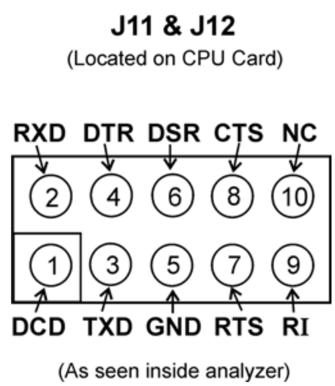


Figure 8-2: Default Pin Assignments for CPU COM Port connector (RS-232)

Teledyne API offers two mating cables, one of which should be applicable for your use.

- Part number WR000077, a DB-9 female to DB-9 female cable, 6 feet long. Allows connection of the serial ports of most personal computers. Also available as Option 60 (see Section 5.7.1).
- Part number WR000024, a DB-9 female to DB-25 male cable. Allows connection to the most common styles of modems (e.g. Hayes-compatible) and code activated switches.

Both cables are configured with straight-through wiring and should require no additional adapters.

NOTE

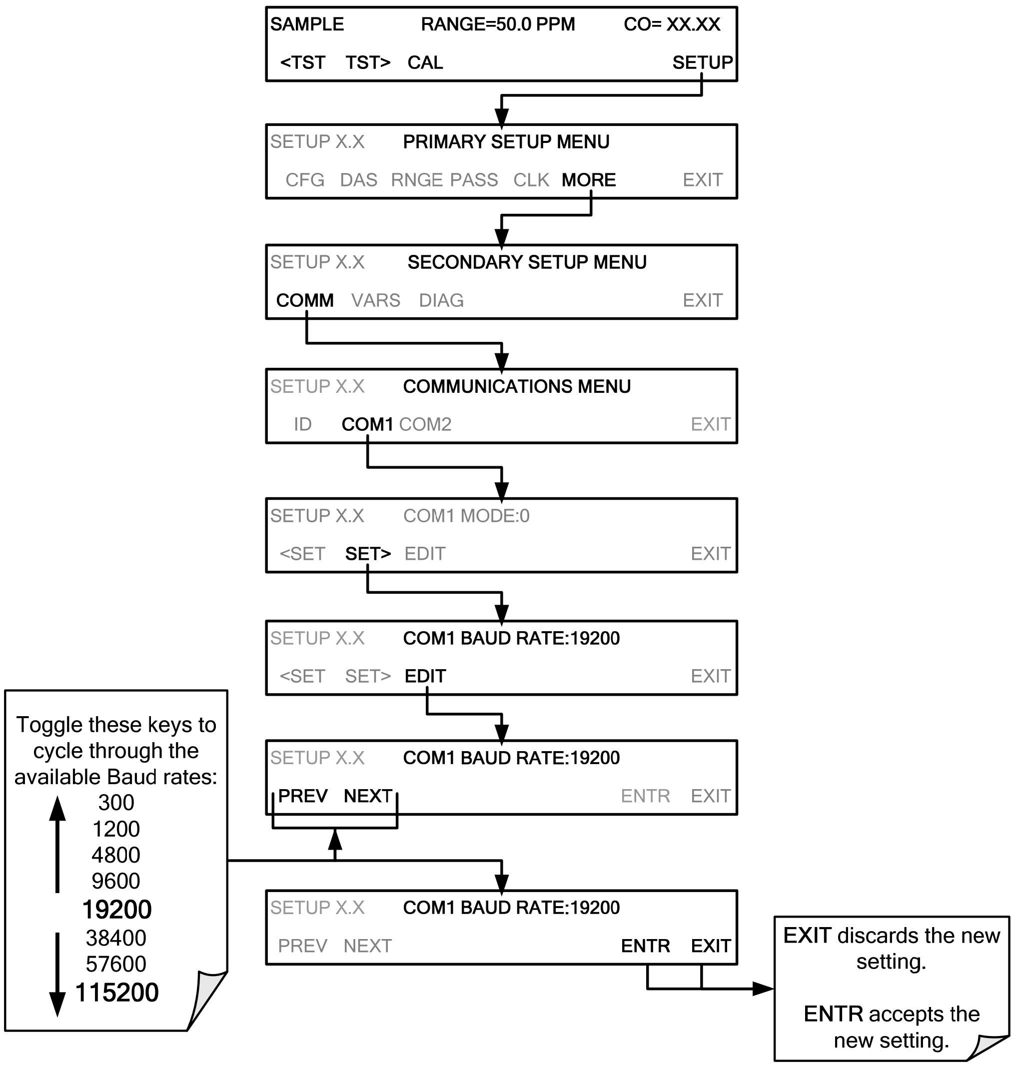
Cables that appear to be compatible because of matching connectors may incorporate internal wiring that makes the link inoperable. Check cables acquired from sources other than Teledyne API for pin assignments before using.

To assist in properly connecting the serial ports to either a computer or a modem, there are activity indicators just above the RS-232 port. Once a cable is connected between the analyzer and a computer or modem, both the red and green LEDs should be on.

- If the lights are not lit, use small switch on the rear panel to switch it between DTE and DCE modes.
- If both LEDs are still not illuminated, make sure the cable properly constructed.

8.1.3. **COMM PORT BAUD RATE**

To select the baud rate of either one of the COMM ports, press:



8.1.4. COMM PORT COMMUNICATION MODES

Each of the analyzer's serial ports can be configured to operate in a number of different modes, listed in Table 8-1. As modes are selected, the analyzer sums the mode ID numbers and displays this combined number on the front panel display. For example, if quiet mode (01), computer mode (02) and Multi-Drop-Enabled mode (32) are selected, the analyzer would display a combined **MODE ID** of **35**.

Table 8-1: COMM Port Communication Modes

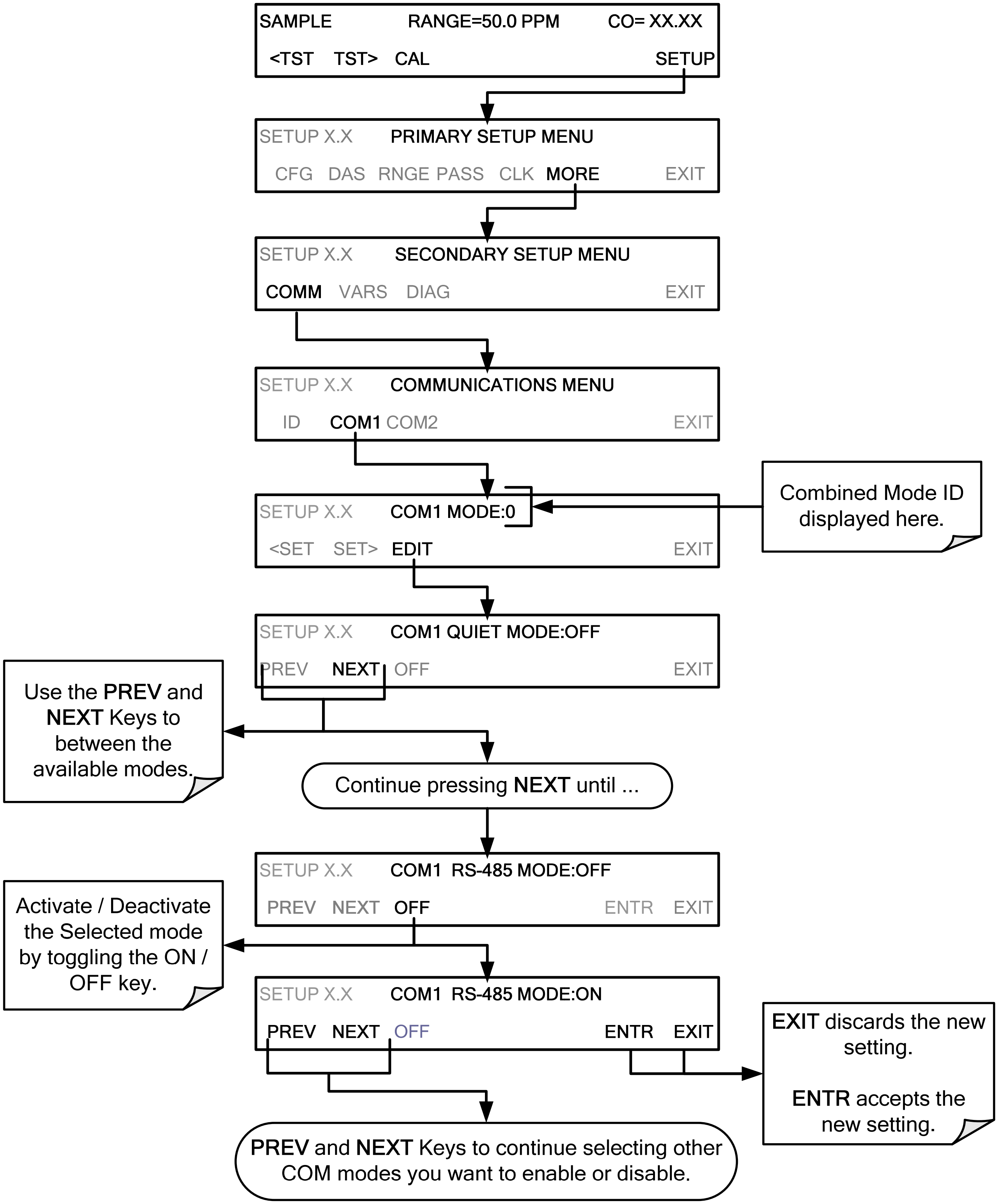
MODE[1]	ID	DESCRIPTION
QUIET	**1**	Quiet mode suppresses any feedback from the analyzer (such as warning messages) to the remote device and is typically used when the port is communicating with a computer program where such intermittent messages might cause communication problems. Such feedback is still available but a command must be issued to receive them.
COMPUTER	**2**	Computer mode inhibits echoing of typed characters and is used when the port is communicating with a computer operated control program.
HESSEN PROTOCOL	**16**	The Hessen communications protocol is used in some European countries. T-API P/N 02252 contains more information on this protocol.
E, 8, 1	**8192**	When turned on this mode switches the **COMM** port settings from • **NO PARITY;** 8 data bits; 1 stop bit to **EVEN PARITY**; 8 data bits; 1 stop bit.
E, 7, 1	**2048**	When turned on this mode switches the **COM** port settings from • **NO PARITY; 8 DATA BITS**; 1 stop bit to **EVEN PARITY; 7 DATA BITS**; 1 stop bit.
RS-485	**1024**	Configures the **COM2** Port for RS-485 communication. RS-485 mode has precedence over multidrop mode if both are enabled.
SECURITY	**4**	When enabled, the serial port requires a password before it will respond (see Section 8.1.7.5). If not logged on, the only active command is the '?' request for the help screen.
MULTIDROP PROTOCOL	**32**	Multidrop protocol allows a multi-instrument configuration on a single communications channel. Multidrop requires the use of instrument IDs.
ENABLE MODEM	**64**	Enables to send a modem initialization string at power-up. Asserts certain lines in the RS-232 port to enable the modem to communicate.
ERROR CHECKING[2]	**128**	Fixes certain types of parity errors at certain Hessen protocol installations.
XON/XOFF HANDSHAKE[2]	**256**	Disables XON/XOFF data flow control also known as software handshaking.
HARDWARE HANDSHAKE	**8**	Enables CTS/RTS style hardwired transmission handshaking. This style of data transmission handshaking is commonly used with modems or terminal emulation protocols as well as by Teledyne Instrument's APICOM software.
HARDWARE FIFO2	**512**	Disables the **HARDWARE FIFO** (First In – First Out). When FIFO is enabled it improves data transfer rate for that COM port.
COMMAND PROMPT	**4096**	Enables a command prompt when in terminal mode.

[1] Modes are listed in the order in which they appear in the **SETUP → MORE → COMM → COM[1 OR 2] → MODE** menu

[2] The default setting for this feature is **ON.** Do not disable unless instructed to by Teledyne API's Customer Service personnel.

> **Note**
>
> **Communication Modes for each COMM port must be configured independently.**

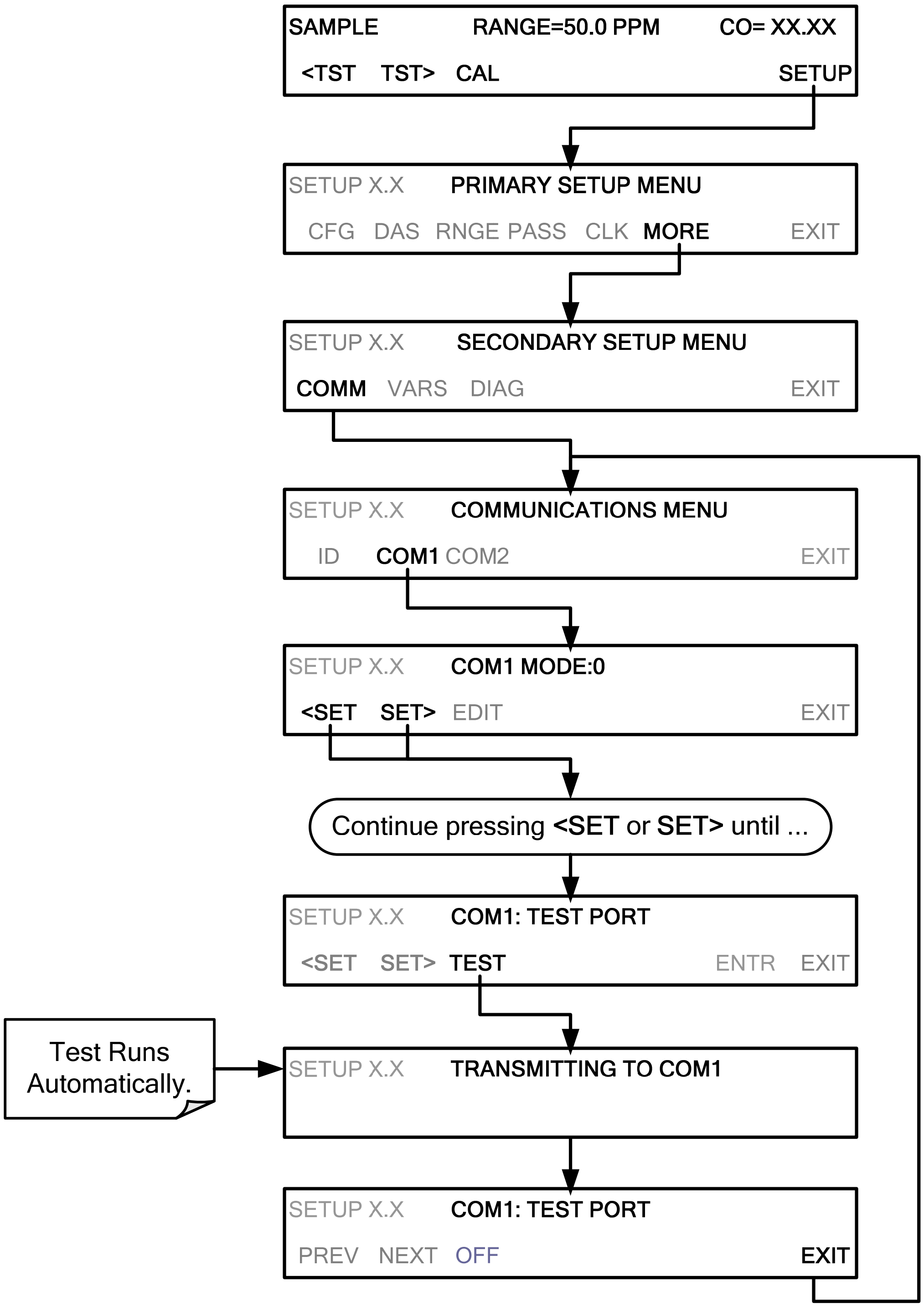
Press the following keys to select communication modes for a one of the COMM ports, such as the following example where **RS-485** mode is enabled:



8.1.5. **COMM PORT TESTING**

The serial ports can be tested for correct connection and output in the **COMM** menu. This test sends a string of 256 ‘w’ characters to the selected COMM port. While the test is running, the red LED on the rear panel of the analyzer should flicker.

To initiate the test press the following key sequence:



8.1.6. MACHINE ID

Each type of Teledyne API's analyzer is configured with a default **ID** code.

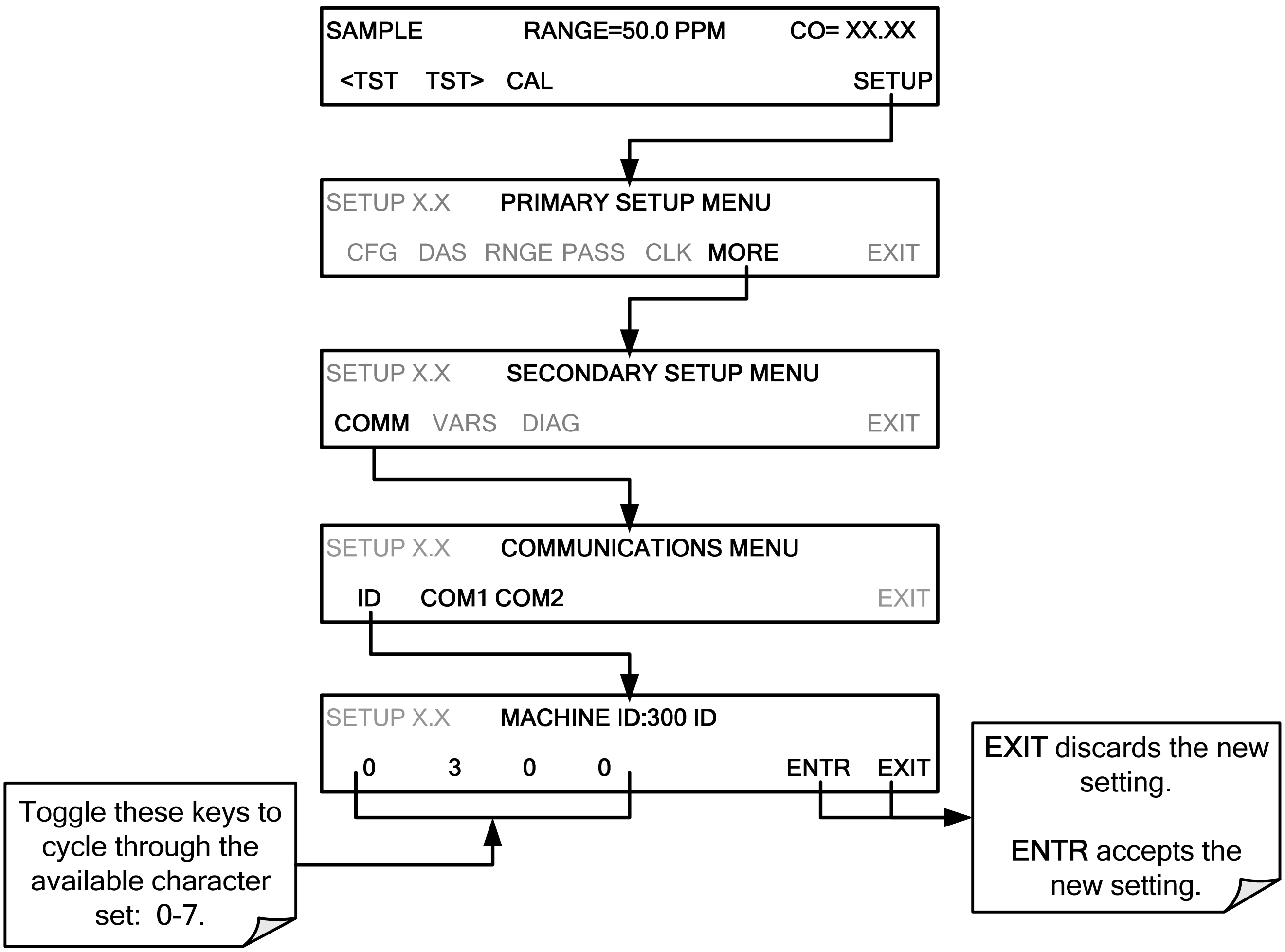
- The default **ID** code for the M300E/EM Analyzers is **300**.

The **ID** number is only important if more than one analyzer is connected to the same communications channel such as when several analyzers are:

- On the same Ethernet LAN (see Section 8.4);
- in a RS-232 multidrop chain (see Section 8.2) or;
- operating over a RS-485 network (See Section 8.3).

If two analyzers of the same model type are used on one channel, the **ID** codes of one or both of the instruments needs to be changed.

To edit the instrument's ID code, press:



The ID can also be used for to identify any one of several analyzers attached to the same network but situated in different physical locations.

8.1.7. **TERMINAL OPERATING MODES**

The M300E/EM can be remotely configured, calibrated or queried for stored data through the serial ports. As terminals and computers use different communication schemes, the analyzer supports two communicate modes specifically designed to interface with these two types of devices.

- The **COMPUTER MODE** is used when the analyzer is connected to a computer with a dedicated interface program.
- The **INTERACTIVE MODE** is used with a terminal emulation programs such as HyperTerminal or a “dumb” computer terminal. The commands that are used to operate the analyzer in this mode are listed in Table 8-2.

8.1.7.1. **Help Commands in Terminal Mode**

Table 8-2: Terminal Mode Software Commands

COMMAND	Function
Control-T	Switches the analyzer to terminal mode (echo, edit). If mode flags 1 & 2 are OFF, the interface can be used in interactive mode with a terminal emulation program.
Control-C	Switches the analyzer to computer mode (no echo, no edit).
CR (carriage return)	A carriage return is required after each command line is typed into the terminal/computer. The command will not be sent to the analyzer to be executed until this is done. On personal computers, this is achieved by pressing the ENTER key.
BS (backspace)	Erases one character to the left of the cursor location.
ESC (escape)	Erases the entire command line.
?[ID] CR	This command prints a complete list of available commands along with the definitions of their functionality to the display device of the terminal or computer being used. The ID number of the analyzer is only necessary if multiple analyzers are on the same communications line, such as the multi-drop setup.
Control-C	Pauses the listing of commands.
Control-P	Restarts the listing of commands.

8.1.7.2. **Command Syntax**

Commands are not case-sensitive and all arguments within one command (i.e. ID numbers, keywords, data values, etc.) must be separated with a space character.

All Commands follow the syntax:

X [ID] COMMAND <CR>

Where

X	is the command type (one letter) that defines the type of command. Allowed designators are listed in Appendix A-6.
[ID]	is the machine identification number (Section 8.1.6). Example: the Command "? 700" followed by a carriage return would print the list of available commands for the revision of software currently installed in the instrument assigned ID Number 700.
COMMAND	is the command designator: This string is the name of the command being issued (LIST, ABORT, NAME, EXIT, etc.). Some commands may have additional arguments that define how the command is to be executed. Press ? <CR> or refer to Appendix A-6 for a list of available command designators.
<CR>	is a carriage return. All commands must be terminated by a carriage return (usually achieved by pressing the ENTER key on a computer).

Table 8-3: Teledyne API's Serial I/O Command Types

COMMAND	COMMAND TYPE
C	Calibration
D	Diagnostic
L	Logon
T	Test measurement
V	Variable
W	Warning

8.1.7.3. **Data Types**

Data types consist of integers, hexadecimal integers, floating-point numbers, Boolean expressions and text strings.

Integer data: Used to indicate integral quantities such as a number of records, a filter length, etc.

- They consist of an optional plus or minus sign, followed by one or more digits.
- For example, +1, -12, 123 are all valid integers.

Hexadecimal integer data: Used for the same purposes as integers.

- They consist of the two characters "0x," followed by one or more hexadecimal digits (0-9, A-F, a-f), which is the 'C' programming language convention.
- No plus or minus sign is permitted.
- For example, 0x1, 0x12, 0x1234abcd are all valid hexadecimal integers.

Floating-point number: Used to specify continuously variable values such as temperature set points, time intervals, warning limits, voltages, etc.

- They consist of an optional plus or minus sign, followed by zero or more digits, an optional decimal point and zero or more digits.
- At least one digit must appear before or after the decimal point.
- Scientific notation is not permitted.

- For example, +1.0, 1234.5678, -0.1, 1 are all valid floating-point numbers.

Boolean expressions: Used to specify the value of variables or I/O signals that may assume only two values.

- They are denoted by the keywords **ON** and **OFF**.

Text strings: Used to represent data that cannot be easily represented by other data types, such as data channel names, which may contain letters and numbers.

- They consist of a quotation mark, followed by one or more printable characters, including spaces, letters, numbers, and symbols, and a final quotation mark.
- For example, “a”, “1”, “123abc”, and “()[]<>” are all valid text strings.
- It is not possible to include a quotation mark character within a text string.

Some commands allow you to access variables, messages, and other items. When using these commands, you must type the entire name of the item; you cannot abbreviate any names.

8.1.7.4. **Status Reporting**

Reporting of status messages as an audit trail is one of the three principal uses for the RS-232 interface (the other two being the command line interface for controlling the instrument and the download of data in electronic format). You can effectively disable the reporting feature by setting the interface to quiet mode (see Section 8.1.4, Table 8-1).

Status reports include warning messages, calibration and diagnostic status messages. Refer to Appendix A-3 for a list of the possible messages, and this for information on controlling the instrument through the RS-232 interface.

General Message Format:

All messages from the instrument (including those in response to a command line request) are in the format:

X DDD:HH:MM [Id] MESSAGE<CRLF>

Where:

X	is a command type designator, a single character indicating the message type, as shown in the Table 8-3.
DDD:HH:MM	is the time stamp, the date and time when the message was issued. It consists of the Day-of-year (DDD) as a number from 1 to 366, the hour of the day (HH) as a number from 00 to 23, and the minute (MM) as a number from 00 to 59.
[ID]	is the analyzer ID, a number with 1 to 4 digits.
MESSAGE	is the message content that may contain warning messages, test measurements, variable values, etc.
<CRLF>	is a carriage return / line feed pair, which terminates the message.

The uniform nature of the output messages makes it easy for a host computer to parse them into an easy structure. Keep in mind that the front panel display does not give any information on the time a message was issued, hence it is useful to log such messages for trouble-shooting and reference purposes. Terminal emulation programs such as HyperTerminal can capture these messages to text files for later review.

8.1.7.5. COMM Port Password Security

In order to provide security for remote access of the M300E/EM, a **LOGON** feature can be enabled to require a password before the instrument will accept commands. This is done by turning on the **SECURITY MODE** (Mode 4, Table 8-1.

Once the **SECURITY MODE** is enabled, the following items apply.

- A password is required before the port will respond or pass on commands.
- If the port is inactive for one hour, it will automatically logoff, which can also be achieved with the LOGOFF command.
- Three unsuccessful attempts to log on with an incorrect password will cause subsequent logins to be disabled for 1 hour, even if the correct password is used.
- If not logged on, the only active command is the '?' request for the help screen.
- The following messages will be returned at logon:
  - LOGON SUCCESSFUL - Correct password given
  - LOGON FAILED - Password not given or incorrect
  - LOGOFF SUCCESSFUL - Connection terminated successfully

To log on to the M300E/EM Analyzer with **SECURITY MODE** feature enabled, type:

LOGON 940331

NOTE
940331 is the default password.

To change the default password, use the variable **RS-232_PASS** issued as follows:

V RS-232_PASS=NNNNNN

Where N is any numeral between 0 and 9.

8.2. MULTIDROP RS-232 SET UP

The RS-232 multidrop consists of a printed circuit assembly that is seated on the CPU card and is connected by a Y-ribbon cable from its J3 connector to the CPU's COM1 and COM2 connectors. This PCA includes all circuitry required to enable your analyzer for multidrop operation. It converts the instrument's RS232 port to multidrop configuration allowing up to eight Teledyne API's E-Series Analyzers to be connected to the same I/O port of the host computer.

Because both of the DB9 connectors on the analyzer's back panel are needed to construct the multidrop chain, **COM2** is no longer available for separate RS-232 or RS-485 operation; however, with the addition of an Ethernet Option (Option 63A, See Section 5.7.3 and 8.4) the **COM2** port is available for communication over a 10BaseT LAN.

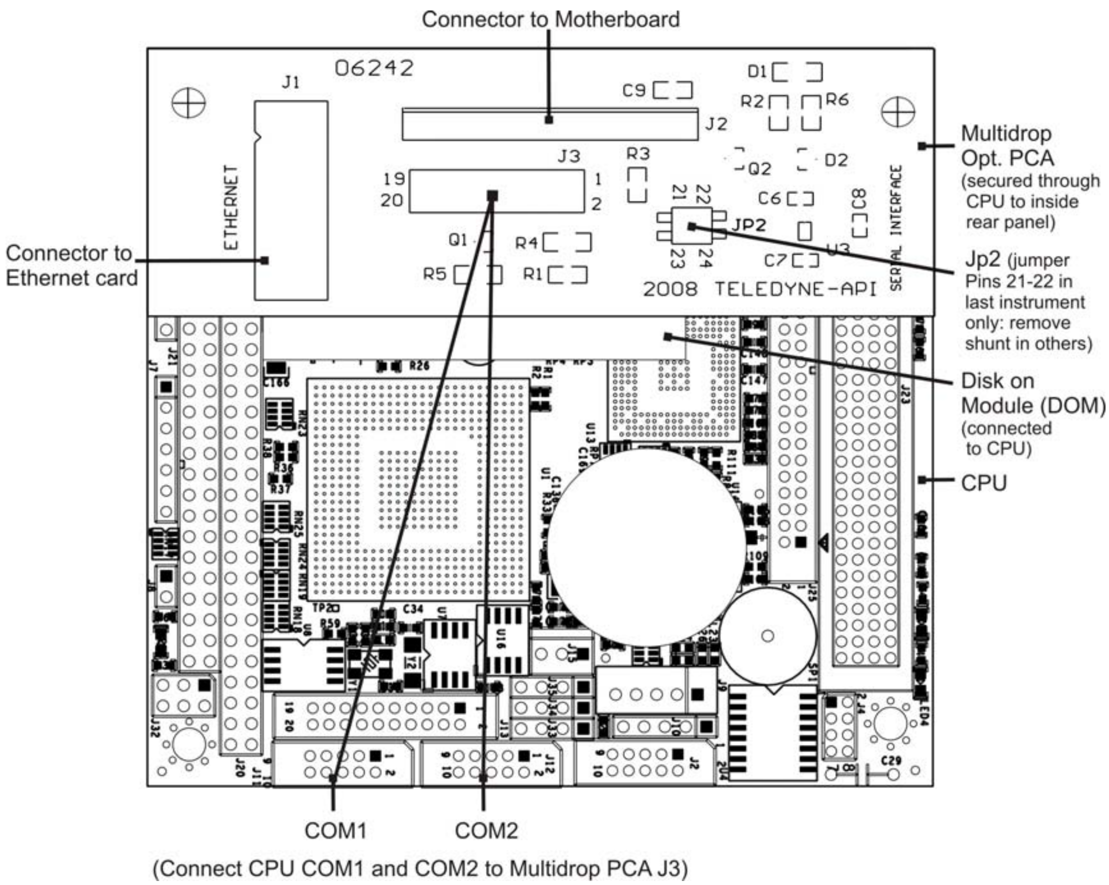


Figure 8-3: Location of JP2 on RS-232-Multidrop PCA (Option 62)

Each analyzer or analyzer in the multidrop chain must have:

- One Teledyne API's Option 62 installed.
- One 6' straight-through, DB9 male → DB9 Female cable (Teledyne API's P/N WR0000101) is required for each analyzer.

To set up the network, for each instrument:

1. With **NO power** to the instrument, remove its top cover and locate JP2 on the multidrop PCA, which is assembled with a shunt that jumpers Pins 21 ↔ 22 (**Error! Reference source not found.**).
2. Remove and store the shunt (place the shunt on one pin only) for all instruments in the network except the instrument that is to be the last: make sure a shunt is in place connecting Pins 21 ↔ 22 for the last instrument.

Note: If you are adding an instrument to the end of a previously configured chain, remove the shunt between Pins 21 ↔ 22 of JP2 on the multidrop PCA in the instrument that was previously the last instrument in the chain.

3. Close the instrument.
4. Using straight-through, DB9 male → DB9 Female cable, interconnect the host and the analyzers as shown in Figure 8-4.
5. BEFORE communicating from the host, power on the instruments and check that the Machine ID code is unique for each. (On the front panel menu, use SETUP>MORE>COMM>ID. Note that the default ID is typically the model number; to change the 4-digit identification number, press the key below the corresponding digit to be changed).

NOTE

Teledyne API recommends setting up the first link, between the Host and the first instrument and testing it before setting up the rest of the chain.

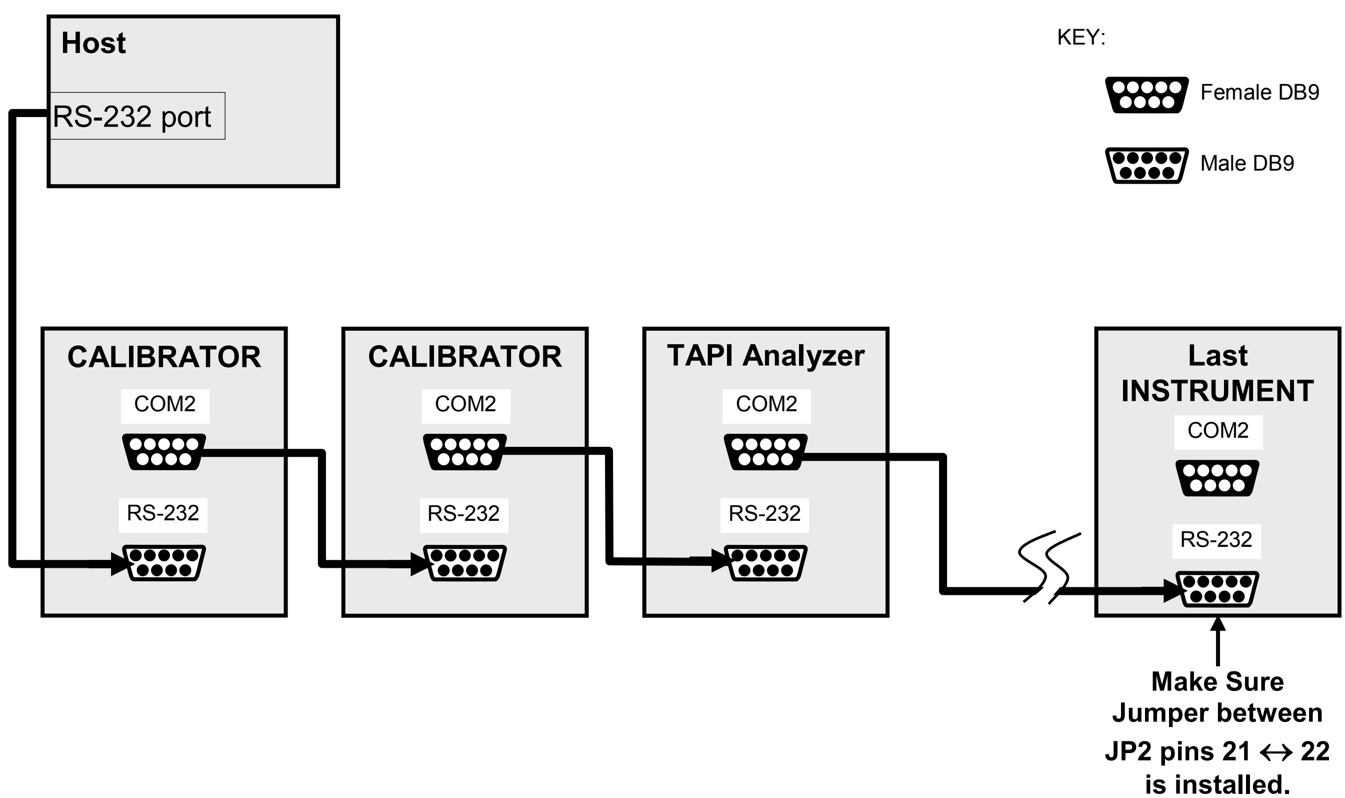


Figure 8-4: RS-232-Multidrop PCA Host/Analyzer Interconnect Diagram

8.3. RS-485 CONFIGURATION OF COM2

As delivered from the factory, **COM2** is configured for RS-232 communications. This port can be reconfigured for operation as a non-isolated, half-duplex RS-485 port capable of supporting up to 32 instruments with a maximum distance between the host and the furthest instrument being 4000 feet. If you require full duplex or isolated operation, please contact Teledyne API's Customer Service.
To reconfigure **COM2** as an RS-485 port:

- Locate J32 and move the shunt from Pins 1 ↔ 2 to Pins 3 ↔ 4.
- Remove the connector from J12.
- Plug the RS-485 connector into J15.

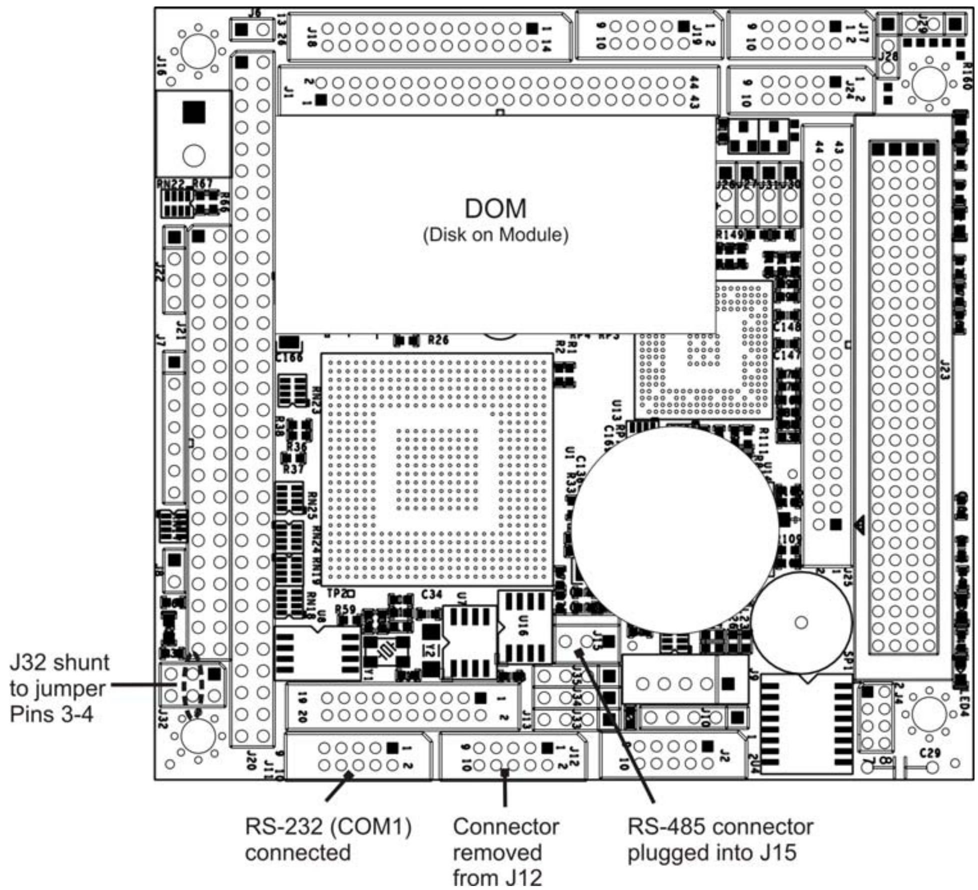


Figure 8-5: CPU RS-485 Setup

When **COM2** is configured for RS-485 operation the port uses the same female DB-9 connector on the back of the instrument as when **COM2** is configured for RS-232 operation, however, the pin assignments are different.

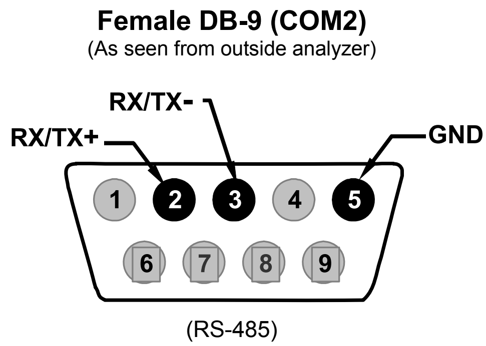


Figure 8-6: Back Panel Connector Pin-Outs for COM2 in RS-485 Mode.

The signal from this connector is routed from the motherboard via a wiring harness to a 3-pin connector on the CPU card, J15.

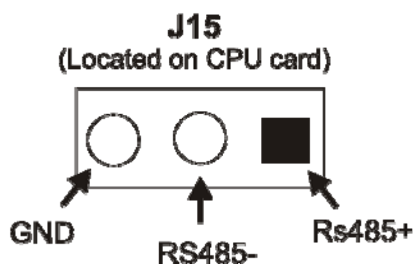


Figure 8-7: CPU Connector Pin-Outs for COM2 in RS-485 Mode

NOTE **The DCE/DTE switch has no effect on COM2.**

8.4. REMOTE ACCESS VIA THE ETHERNET

When equipped with the optional Ethernet interface, the analyzer can be connected to any standard 10BaseT Ethernet network via low-cost network hubs, switches or routers. The interface operates as a standard TCP/IP device on port 3000. This allows a remote computer to connect through the internet to the analyzer using APICOM, terminal emulators or other programs.

The firmware on board the Ethernet card automatically sets the communication modes and baud rate (115,200 kBaud) for the **COM2** port. Once the Ethernet option is installed and activated, the **COM2** submenu is replaced by a new submenu, **INET**. This submenu is used to manage and configure the Ethernet interface with your LAN or Internet Server(s).

The card has four LEDs that are visible on the rear panel of the analyzer, indicating its current operating status.

Table 8-4: Ethernet Status Indicators

LED	FUNCTION
LNK (green)	ON when connection to the LAN is valid.
ACT (yellow)	Flickers on any activity on the LAN.
TxD (green)	Flickers when the RS-232 port is transmitting data.
RxD (yellow)	Flickers when the RS-232 port is receiving data.

The Ethernet interface operates in ”polled” mode with a polling period that ranges from between 250 ms and 2 seconds.

- When there is port activity, the polling rate is the minimum, 250 ms.
- When port activity is quiet, the polling rate lengthens to up to 2-seconds to reduce the burden on the instruments CPU.

NOTE

Commands should not be issued faster than twice a second for reliable operation.

8.4.1. ETHERNET CARD COM2 COMMUNICATION MODES AND BAUD RATE

The firmware on board the Ethernet card automatically sets the communication modes for the COM2 port. The baud rate is also automatically set at 115,200 kBaud.

8.4.2. CONFIGURING THE ETHERNET INTERFACE OPTION USING DHCP

The Ethernet option for you M300E/EM uses Dynamic Host Configuration Protocol (DHCP) to configure its interface with your LAN automatically. This requires your network servers also be running DHCP. The analyzer will do this the first time you turn the instrument on after it has been physically connected to your network. Once the instrument is connected and turned on, it will appear as an active device on your network without any extra set up steps or lengthy procedures.

NOTE

It is a good idea to check the INET settings the first time you power up your analyzer after it has been physically connected to the LAN/Internet to make sure that the DHCP has successfully downloaded the appropriate information from you network server(s).

The Ethernet configuration properties are viewable via the analyzer's front panel.

Table 8-5: LAN/Internet Configuration Properties

PROPERTY	DEFAULT STATE		DESCRIPTION
DHCP STATUS	On	Editable	This displays whether the DHCP is turned ON or OFF.
INSTRUMENT IP ADDRESS	Configured by DHCP	**EDIT** key disabled when DHCP is **ON**	This string of four packets of 1 to 3 numbers each (e.g. 192.168.76.55.) is the address of the analyzer itself.
GATEWAY IP ADDRESS	Configured by DHCP	**EDIT** key disabled when DHCP is **ON**	A string of numbers very similar to the Instrument IP address (e.g. 192.168.76.1.) that is the address of the computer used by your LAN to access the Internet.
SUBNET MASK	Configured by DHCP	**EDIT** key disabled when DHCP is **ON**	Also, a string of four packets of 1 to 3 numbers each (e.g. 255.255.252.0) that defines that identifies the LAN to which the device is connected. All addressable devices and computers on a LAN must have the same subnet mask. Any transmissions sent devices with different subnet masks are assumed to be outside of the LAN and are routed through a different gateway computer onto the Internet.
TCP PORT1[1]	**3000**	Editable, but **DO NOT CHANGE**	TSP listening port 1. This port is used for standard Ethernet communications. The number defines the terminal control port by which the instrument is addressed by terminal emulation software, such as Teledyne API's APICOM.
TCP PORT2[1]	**520**	Editable, but **DO NOT CHANGE**	TSP listening port 2. This port is reserved for the M300E/EM Analyzer's optional Modbus® capability. The number matches the default address specified by Modbus® specifications.
HOST NAME	DEFAULT = Model Type	Editable	The name by which your analyzer appears when addressed by other computers on the LAN or via the Internet. While the default setting is the model type (e.g. M300E, etc.) the host name may be changed to fit customer needs.
ONLINE	**ON**	Editable	Enables or disables the M300E/EM Analyzer's two TCP Ports. The TCP ports are inactive when this is set to **OFF.**

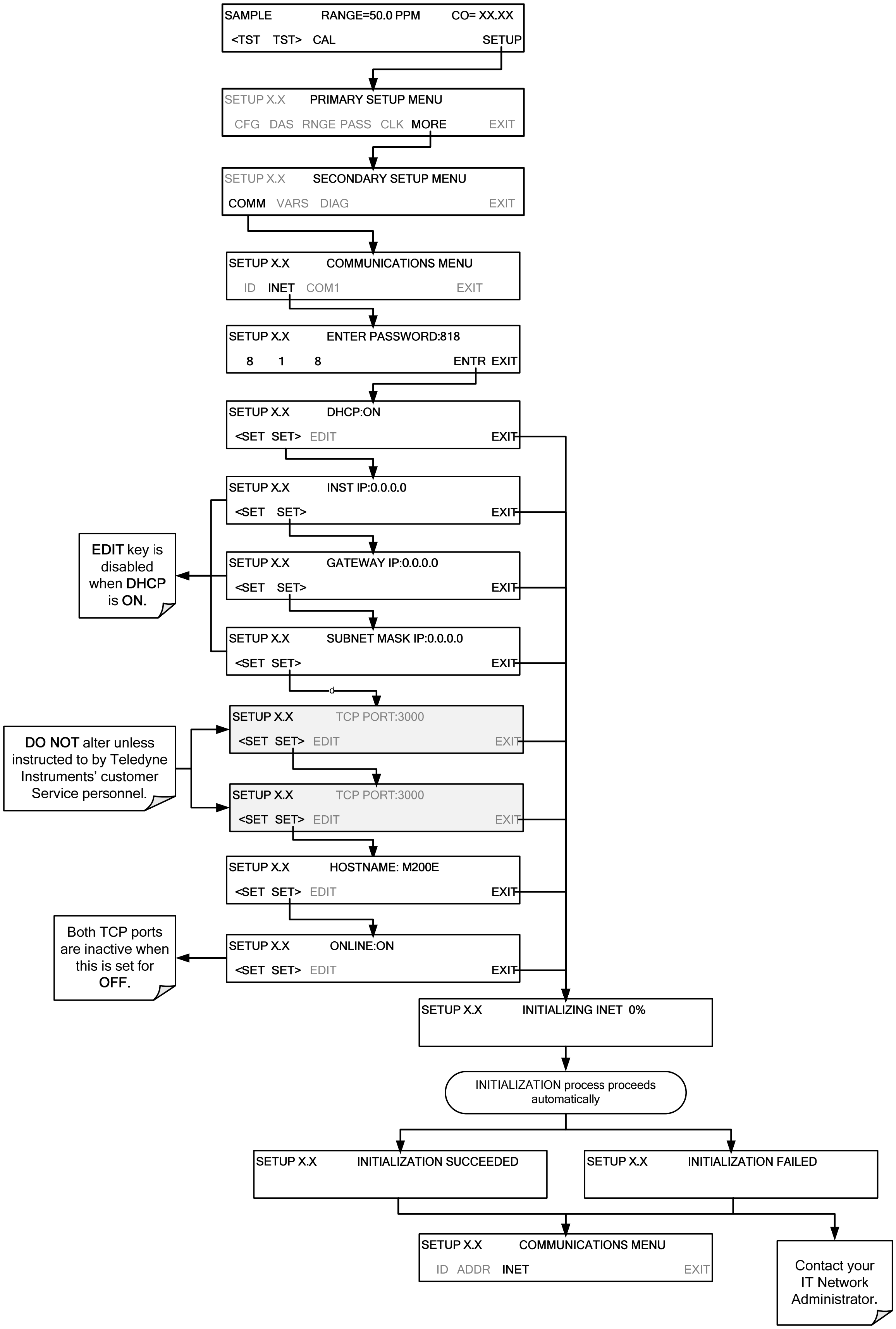
[1] **DO NOT CHANGE** the setting for this property unless instructed to by Teledyne API's Customer Service personnel.

NOTE

If the gateway IP, instrument IP and the subnet mask are all zeroes (e.g. "0.0.0.0"), the DCHP was not successful in which case you may have to configure the analyzer's Ethernet properties manually.

See your network administrator.

To view the above properties listed in Table 8-5, press:



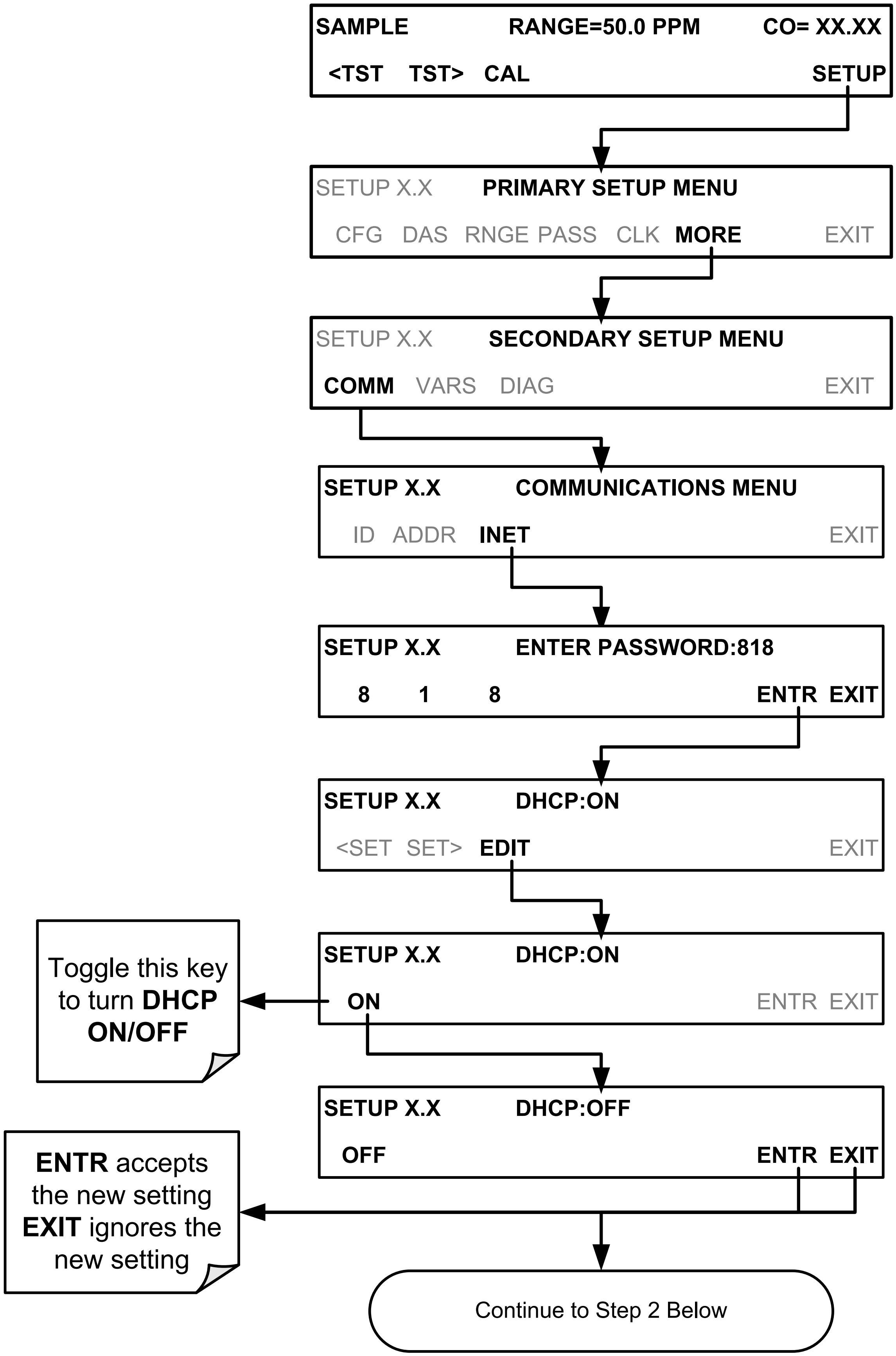
8.4.3. MANUALLY CONFIGURING THE NETWORK IP ADDRESSES

There are several circumstances when you may need to configure the interface settings of the analyzer's Ethernet card manually. The **INET** submenu may also be used to edit the Ethernet card's configuration properties.

- Your LAN is not running a DHCP software package;
- The DHCP software is unable to initialize the analyzer's interface;
- You wish to program the interface with a specific set of IP addresses that may not be the ones automatically chosen by DHCP.

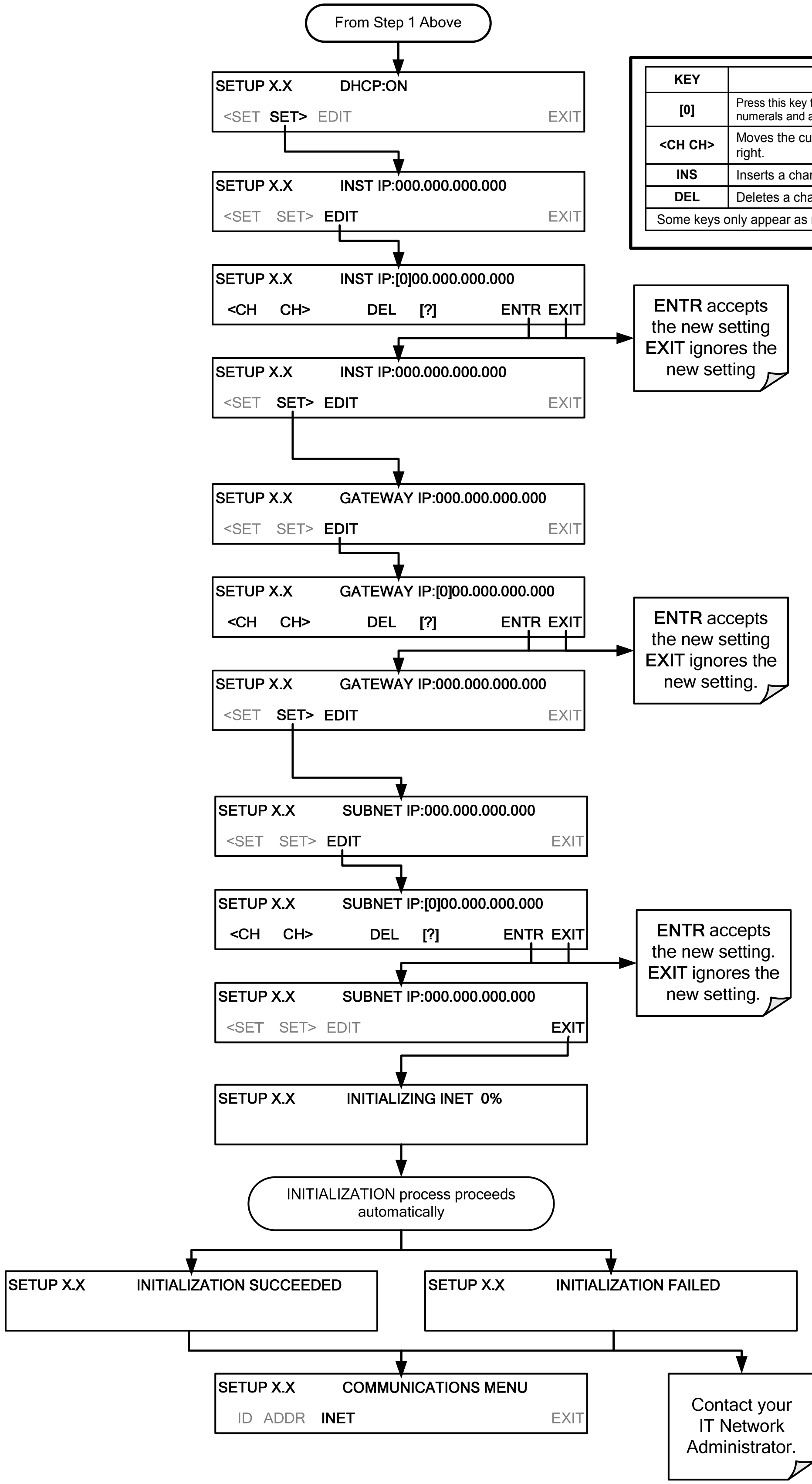
Editing the Ethernet Interface properties is a two-step process. start /low firmware.exe /y

STEP 1: Turn DHCP **OFF**: While DHCP is turned **ON**, the ability to set the **INSTRUMENT IP**, **GATEWAY IP** and **SUBNET MASK** manually is disabled.


SAMPLE RANGE=50.0 PPM CO= XX.XX
<TST TST> CAL SETUP
SETUP X.X PRIMARY SETUP MENU
CFG DAS RNGE PASS CLK MORE EXIT
SETUP X.X SECONDARY SETUP MENU
COMM VARS DIAG EXIT
SETUP X.X COMMUNICATIONS MENU
ID ADDR INET EXIT
SETUP X.X ENTER PASSWORD:818
8 1 8 ENTR EXIT
SETUP X.X DHCP:ON
<SET SET> EDIT EXIT
SETUP X.X DHCP:ON
ON ENTR EXIT
Toggle this key to turn DHCP ON/OFF
SETUP X.X DHCP:OFF
OFF ENTR EXIT
ENTR accepts the new setting EXIT ignores the new setting
Continue to Step 2 Below

STEP 2: Configure the **INSTRUMENT IP**, **GATEWAY IP** and **SUBNET MASK** addresses by pressing:

KEY	FUNCTION
[0]	Press this key to cycle through the range of numerals and available characters ("**0 – 9**" & "**.**")
<CH CH>	Moves the cursor one character to the left or right.
INS	Inserts a character before the cursor location.
DEL	Deletes a character at the cursor location.
Some keys only appear as needed.	

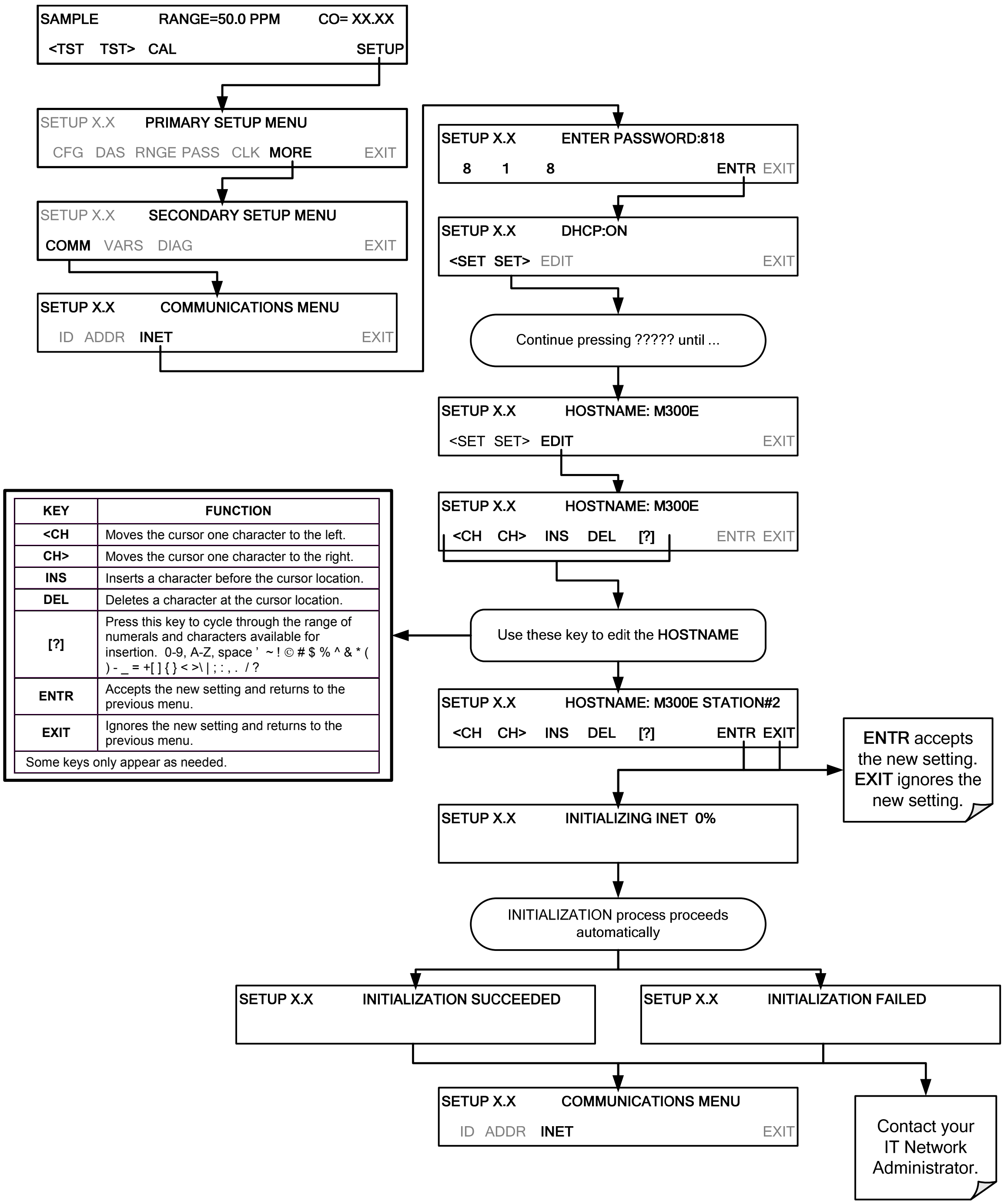


8.4.4. **CHANGING THE ANALYZER'S HOSTNAME**

The **HOSTNAME** is the name by which the analyzer appears on your network.

- The default name for all Teledyne API's M300E Analyzers is **M300E**.
- The default name for all Teledyne API's M300EM Analyzers is **M300EM**.

To change this name (particularly if you have more than one M300E/EM Analyzer on your network), press:



KEY	FUNCTION
<CH	Moves the cursor one character to the left.
CH>	Moves the cursor one character to the right.
INS	Inserts a character before the cursor location.
DEL	Deletes a character at the cursor location.
[?]	Press this key to cycle through the range of numerals and characters available for insertion. 0-9, A-Z, space ' ~ ! © # $ % ^ & * ( ) - _ = +[ ] { } < >\ | ; : , . / ?
ENTR	Accepts the new setting and returns to the previous menu.
EXIT	Ignores the new setting and returns to the previous menu.
Some keys only appear as needed.	

8.5. MODBUS SETUP

The following set of instructions assumes that the user is familiar with MODBUS communications, and provides minimal information to get started. For additional instruction, please refer to the Teledyne API MODBUS manual, PN 06276. Also refer to www.modbus.org for MODBUS communication protocols.

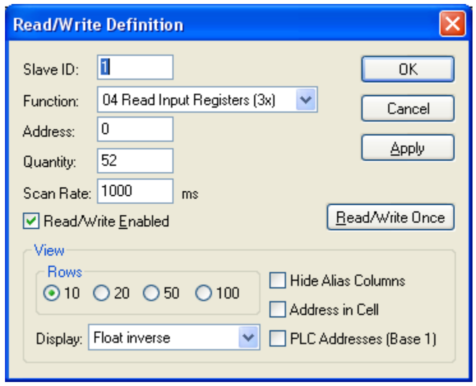
Minimum Requirements

- Instrument firmware with MODBUS capabilities installed.
- MODBUS-compatible software (TAPI uses MODBUS Poll for testing; see www.modbustools.com)
- Personal computer
- Communications cable (Ethernet or USB or RS232)
- Possibly a null modem adapter or cable

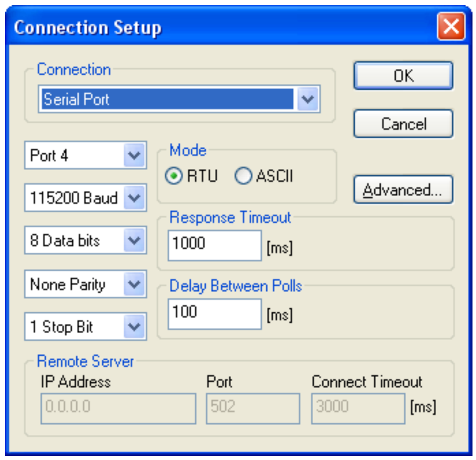
Actions

Set Com Mode parameters Comm	Ethernet: Using the front panel menu, go to SETUP – MORE – COMM – INET; scroll through the INET submenu until you reach TCP PORT 2 (the standard setting is 502), then continue to TCP PORT 2 MODBUS TCP/IP; press EDIT and toggle the menu button to change the setting to ON, then press ENTR. (Change Machine ID if needed: see "Slave ID"). RS232: Using the front panel menu, go to SETUP – MORE – COMM – COM2 – EDIT; scroll through the COM2 EDIT submenu until the display shows COM2 MODBUS RTU: OFF (press OFF to change the setting to ON. Scroll NEXT to COM2 MODBUS ASCII and ensure it is set to OFF. Press ENTR to keep the new settings. (If RTU is not available with your communications equipment, set the COM2 MODBUS ASCII setting to ON and ensure that COM2 MODBUS RTU is set to OFF. Press ENTR to keep the new settings).
Slave ID	A MODBUS slave ID must be set for each instrument. Valid slave ID's are in the range of 1 to 247. If your analyzer is connected to a serial network (ie. RS-485), a unique Slave ID must be assigned to each instrument. To set the slave ID for the instrument, go to SETUP – MORE – COMM – ID. The default MACHINE ID is the same as the model number. Toggle the menu buttons to change the ID.
Reboot analyzer	For the settings to take effect, power down the analyzer, wait 5 seconds, and power up the analyzer.
Make appropriate cable connections	Connect your analyzer either: • via its Ethernet or USB port to a PC (this may require a USB-to-RS232 adapter for your PC; if so, also install the sofware driver from the CD supplied with the adapter, and reboot the computer if required), or • via its COM2 port to a null modem (this may require a null modem adapter or cable).
Specify MODBUS software settings (examples used here are for MODBUS Poll software)	1. Click Setup / [Read / Write Definition] /. a. In the Read/Write Definition window (see example that follows) select a **Function** (what you wish to read from the analyzer). b. Input **Quantity** (based on your firware's register map). c. In the View section of the Read/Write Definition window select a **Display** (typically Float Inverse). d. Click **OK**. 2. Next, click Connection/Connect. a. In the Connection Setup window (see example that follows), select the options based on your computer. b. Press **OK**.
Read the Modbus Poll Register	Use the Register Map to find the test parameter names for the values displayed (see example that follows If desired, assign an alias for each.

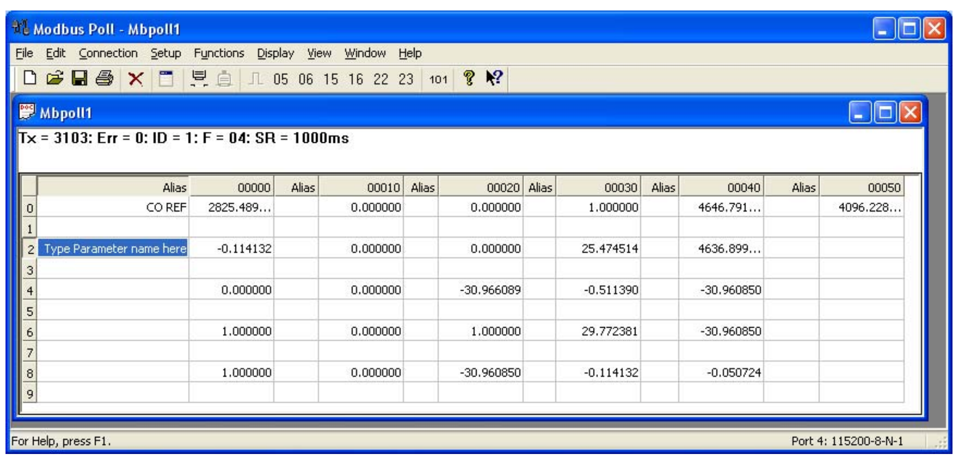
Example Read/Write Definition window:



Example Connection Setup window:



Example MODBUS Poll window:



8.5.1. REMOTE ACCESS BY MODEM

The M300E/EM can be connected to a modem for remote access. This requires a cable between the analyzer's COMM port and the modem, typically a DB-9F to DB-25M cable (available from Teledyne API with P/N WR0000024).

Once the cable has been connected, check to make sure:

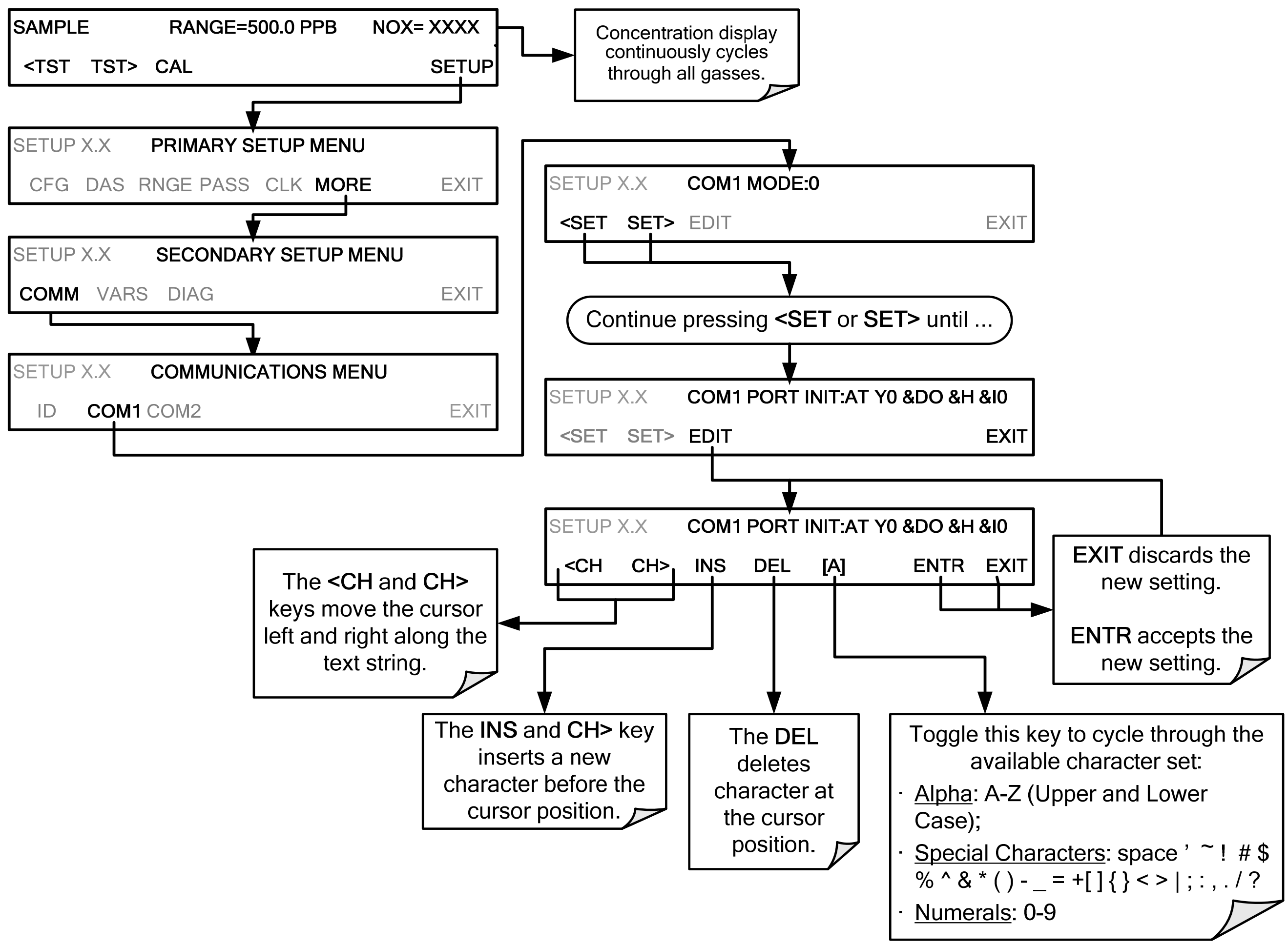
- The DTE-DCE is in the DCE position.
- The M300E/EM COMM port is set for a baud rate that is compatible with the modem,
- The modem is designed to operate with an 8-bit word length with one stop bit.
- The MODEM ENABLE communication mode is turned on (Mode 64, see Table 8-1).

Once this is completed, the appropriate setup command line for your modem can be entered into the analyzer. The default setting for this feature is:

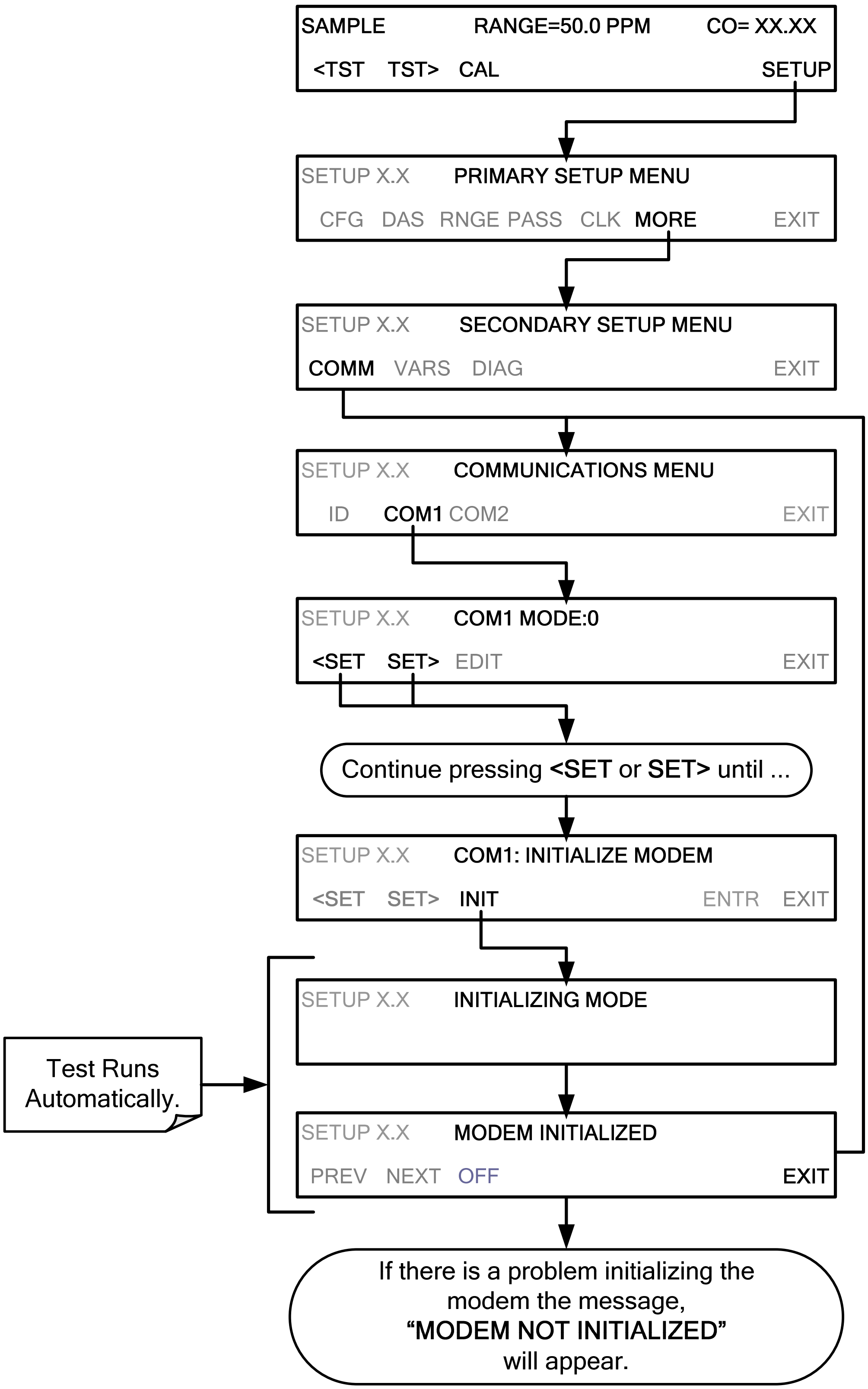
AT Y0 &D0 &H0 &I0 S0=2 &B0 &N6 &M0 E0 Q1 &W0

This string can be altered to match your modem's initialization and can be up to 100 characters long.

To change this setting press:



To initialize the modem press:



8.6. USING THE M300E/EM WITH A HESSEN PROTOCOL NETWORK

8.6.1. GENERAL OVERVIEW OF HESSEN PROTOCOL

The Hessen protocol is a multidrop protocol, in which several remote instruments are connected via a common communications channel to a host computer. The remote instruments are regarded as slaves of the host computer. The remote instruments are unaware that they are connected to a multidrop bus and never initiate Hessen protocol messages. They only respond to commands from the host computer and only when they receive a command containing their own unique ID number.

The Hessen protocol is designed to accomplish two things: to obtain the status of remote instruments, including the concentrations of all the gases measured; and to place remote instruments into zero or span calibration or measure mode. API's implementation supports both of these principal features.

The Hessen protocol is not well defined, therefore while API's application is completely compatible with the protocol itself, it may be different from implementations by other companies.

NOTE

The following sections describe the basics for setting up your instrument to operate over a Hessen Protocol network.

For more detailed information as well as a list of host computer commands and examples of command and response message syntax, download the *Manual Addendum for Hessen Protocol* from the Teledyne API web site: http://www.teledyne-api.com/manuals/.

8.6.2. HESSEN COMM PORT CONFIGURATION

Hessen protocol requires the communication parameters of the M300E/EM Analyzer's COMM ports to be set differently than the standard configuration as shown in Table 8-6.

Table 8-6: RS-232 Communication Parameters for Hessen Protocol

PARAMETER	STANDARD	HESSEN
Baud Rate	300 – 19200	1200
Data Bits	8	7
Stop Bits	1	2
Parity	None	Even
Duplex	Full	Half

To change the baud rate of the M300E/EM's COMM ports, see Section 8.1.3.

To change the rest of the COMM port parameters listed in the Table 8-6. Also see Section 8.1 and Table 8-1.

Note

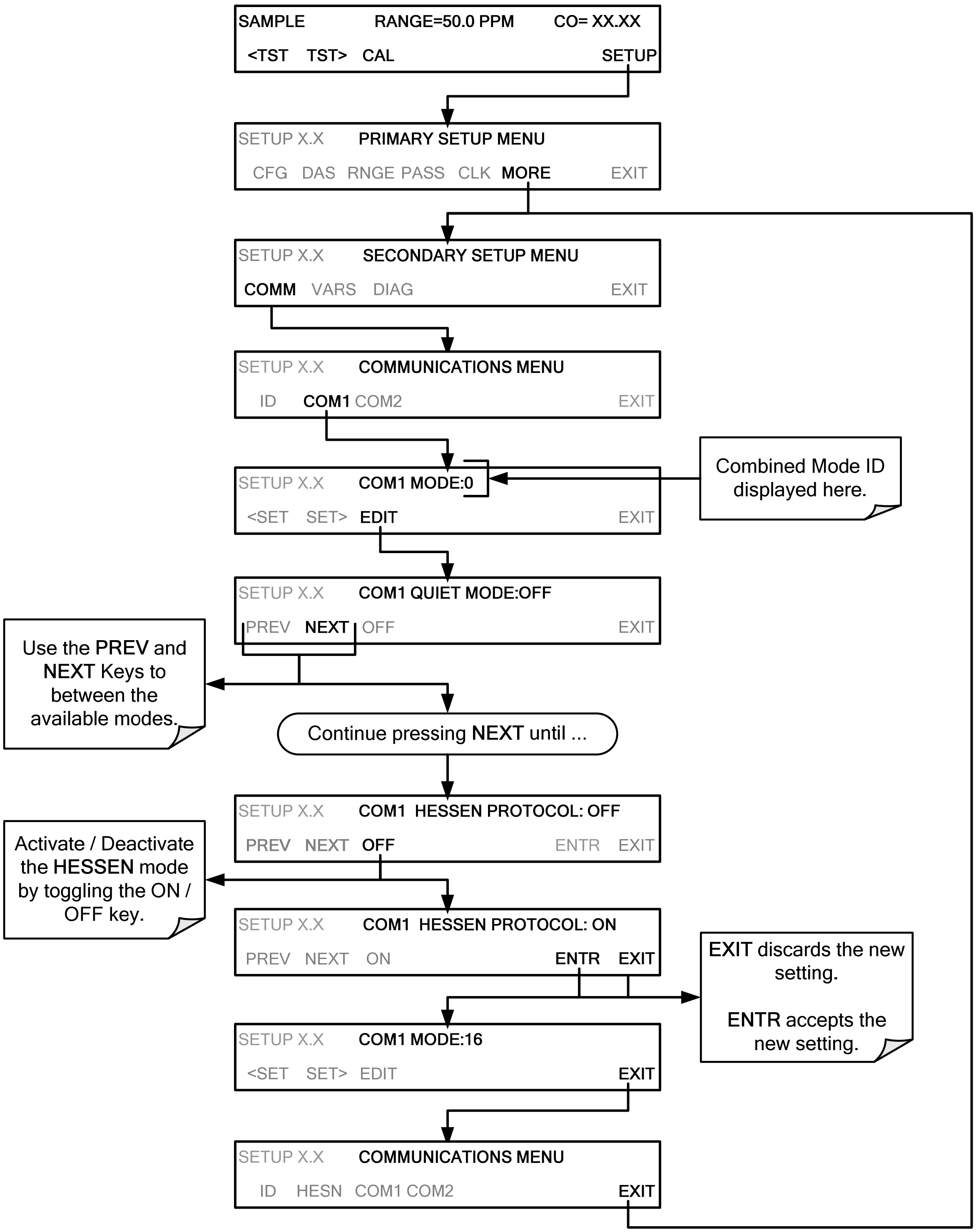
Make sure that the communication parameters of the host computer are also properly set.

Also, the instrument software has a 200 ms latency period before it responds to commands issued by the host computer. This latency should present no problems, but you should be aware of it and not issue commands to the instrument too frequently.

8.6.3. ACTIVATING HESSEN PROTOCOL

Once the COMM port has been properly configured, the next step in configuring the M300E/EM to operate over a Hessen protocol network is to activate the Hessen mode for COMM ports and configure the communication parameters for the port(s) appropriately.

To activate the Hessen Protocol, press:

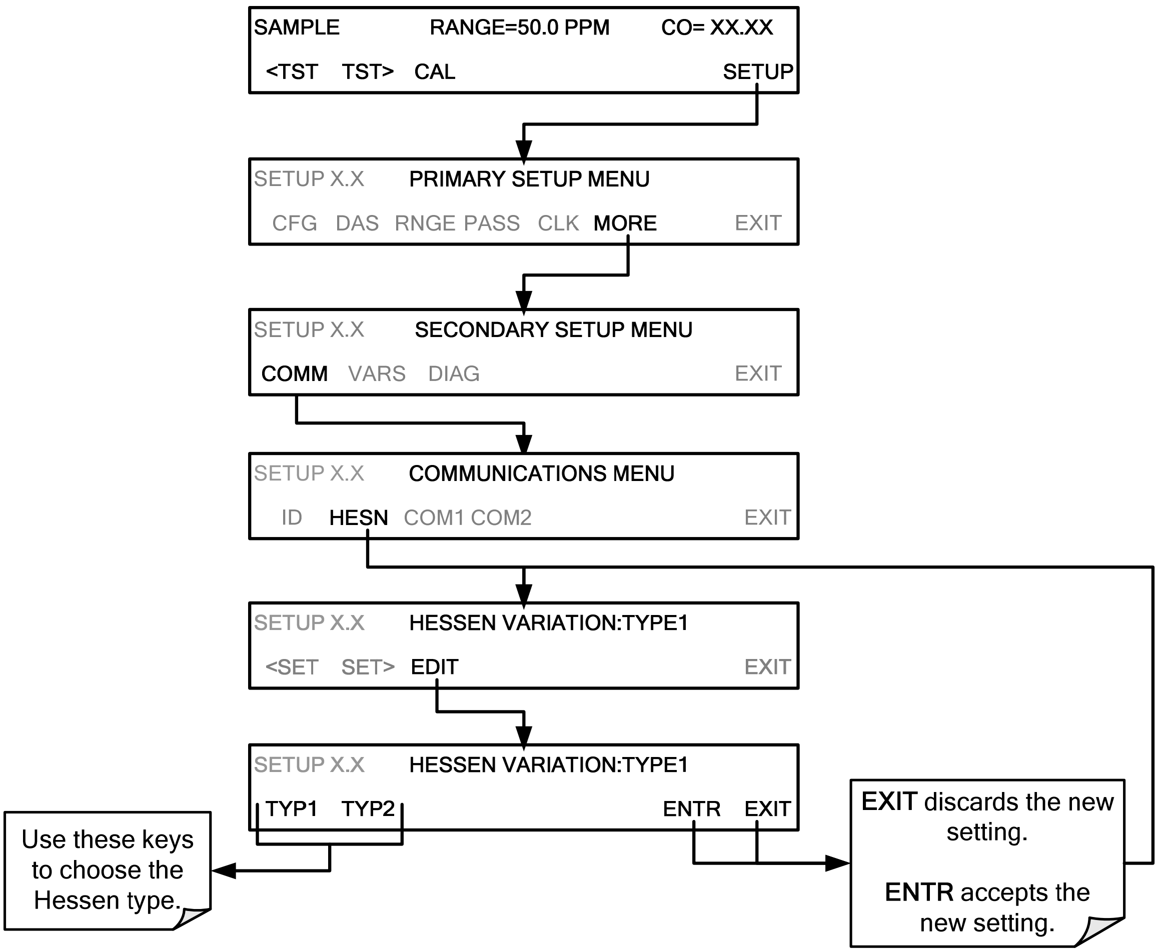


8.6.4. SELECTING A HESSEN PROTOCOL TYPE

Currently there are two versions of Hessen Protocol in use. The original implementation, referred to as **TYPE 1**, and a more recently released version, **TYPE 2** that has more flexibility when operating with instruments that can measure more than one type of gas.

For more specific information about the difference between **TYPE 1** and **TYPE 2** download the *Manual Addendum for Hessen Protocol* from the Teledyne API web site: http://www.teledyne-api.com/manuals/.

To select a Hessen Protocol Type press:



> **NOTE**
>
> **While Hessen Protocol Mode can be activated independently for COM1 and COM2 in the COMMUNICATIONS MENU, the TYPE selection affects both Ports.**

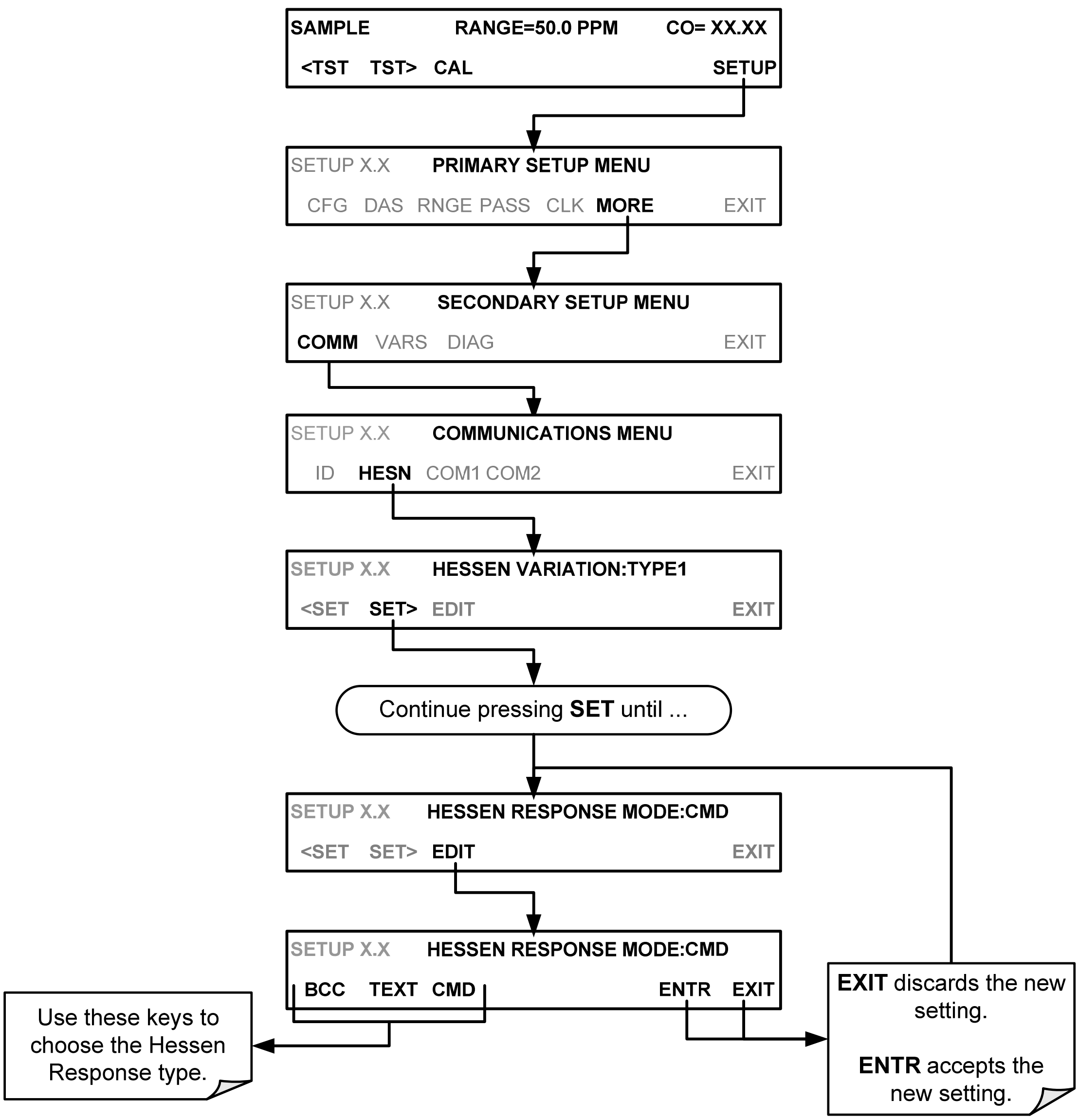
8.6.5. SETTING THE HESSEN PROTOCOL RESPONSE MODE

The Teledyne API's implementation of Hessen Protocol allows the user to choose one of several different modes of response for the analyzer.

Table 8-7: Teledyne API's Hessen Protocol Response Modes

MODE ID	MODE DESCRIPTION
CMD	This is the Default Setting. Reponses from the instrument are encoded as the traditional command format. Style and format of responses depend on exact coding of the initiating command.
BCC	Responses from the instrument are always delimited with <STX> (at the beginning of the response, <ETX> (at the end of the response followed by a 2 digit Block Check Code (checksum), regardless of the command encoding.
TEXT	Responses from the instrument are always delimited with <CR> at the beginning and the end of the string, regardless of the command encoding.

To select a Hessen response mode, press:



8.6.6. HESSEN PROTOCOL GAS LIST ENTRIES

8.6.6.1. Gas List Entry Format and Definitions

The M300E/EM Analyzer keeps a list of available gas types. Each entry in this list is of the following format.

[GAS TYPE],[RANGE],[GAS ID],[REPORTED]

WHERE:

GAS TYPE = The type of gas to be reported (e.g. CO, CO_2, O_2, etc.).

RANGE = The concentration range for this entry in the gas list. This feature permits the user to select which concentration range will be used for this gas list entry. The M300E/EM Analyzer has two ranges: **RANGE1** or LOW & **RANGE2** or HIGH (See Section 6.6.1).

0 - The HESSEN protocol to use whatever range is currently active.

1 - The HESSEN protocol will always use **RANGE1** for this gas list entry.

2 - The HESSEN protocol will always use **RANGE2** for this gas list entry.

3 - Not applicable to the M300E/EM Analyzer.

GAS ID = An identification number assigned to a specific gas. In the case of the M300E/EM Analyzer in its base configuration, there is only one gas CO, and its default GAS ID is 310. (**Note:** This ID number should not be modified).

REPORT = States whether this list entry is to be reported or not reported when ever this gas type or instrument is polled by the HESSEN network. If the list entry is not to be reported this field will be blank.

While the M300E/EM Analyzer is a single gas instrument that measures CO, it can have additional, optional sensors for CO_2 or O_2 installed. The default gas list entries for these three gases are:

CO, 0, 310, REPORTED
CO_2, 0, 311, REPORTED
O_2, 0, 312, REPORTED

These default settings cause the instrument to report the concentration value of the currently active range. If you wish to have just concentration value stored for a specific range, this list entry should be edited or additional entries should be added to the list.

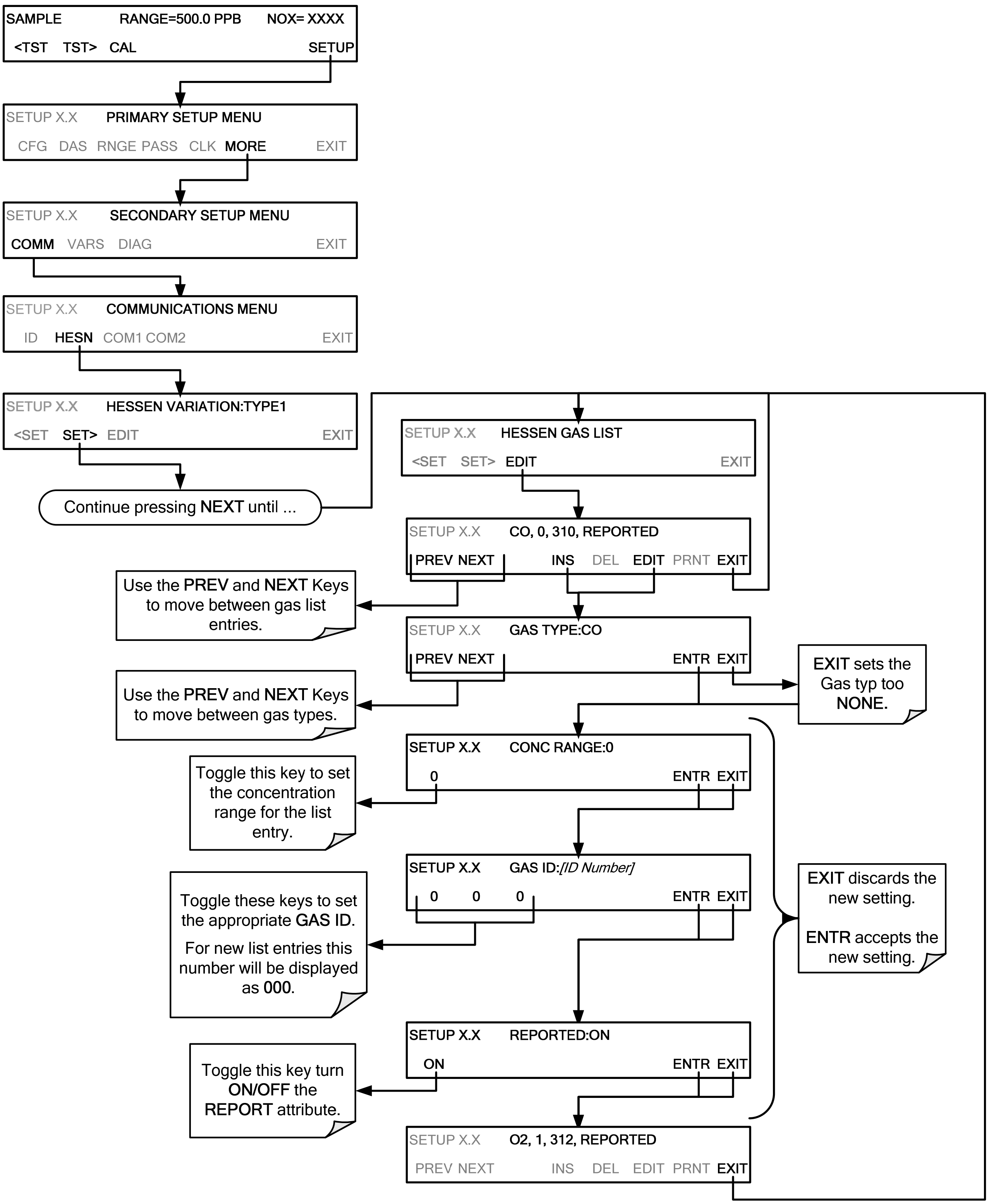
EXAMPLE: Changing the above CO gas list entry to read:

CO, 2, 310, REPORTED

would cause only the last CO reading while **RANGE2** (HIGH) range was active to be recorded.

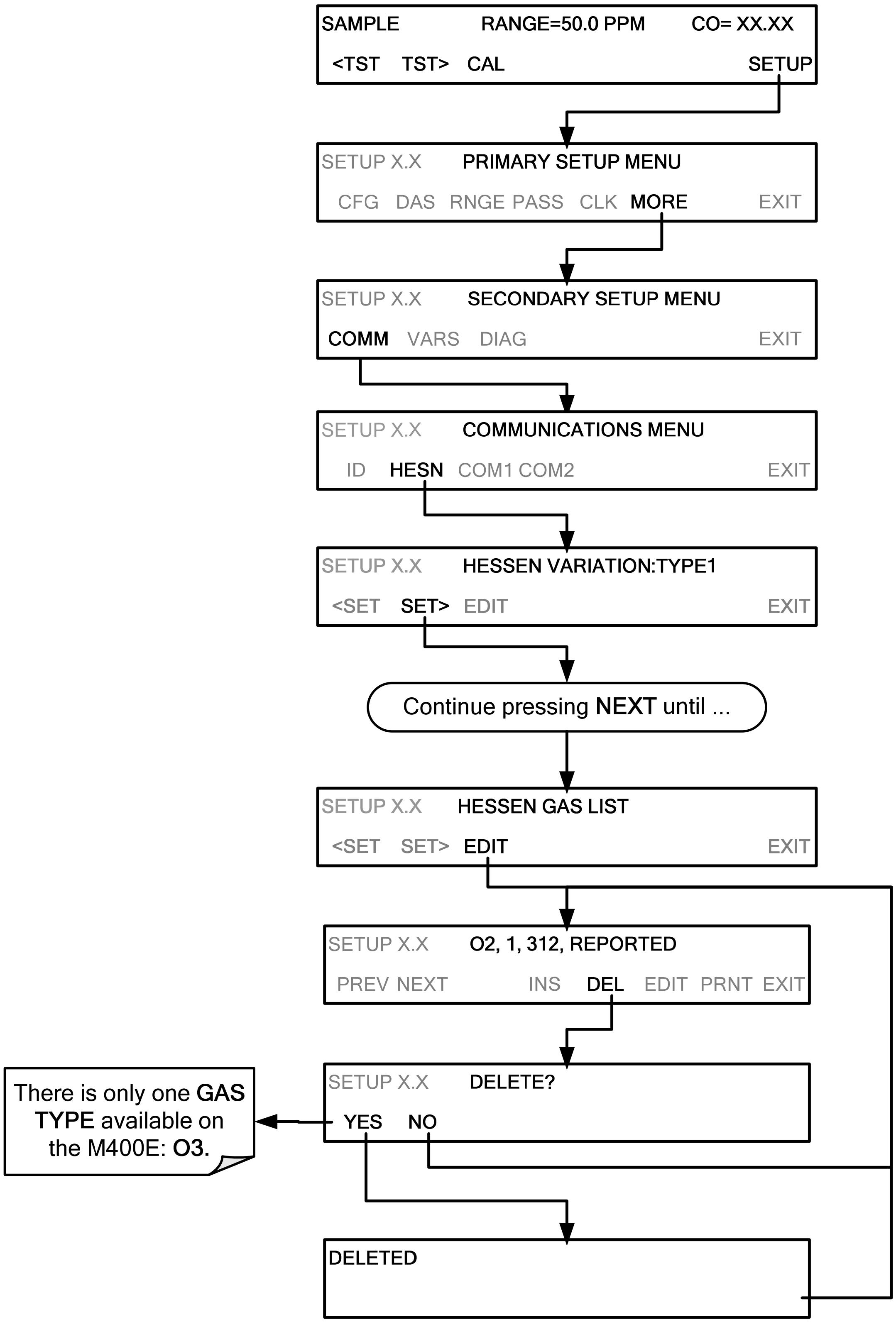
8.6.6.2. **Editing or Adding HESSEN Gas List Entries**

To add or edit an entry to the Hessen Gas List, press:



8.6.6.3. **Deleting HESSEN Gas List Entries**

To delete an entry from the Hessen Gas list, press:



8.6.7. SETTING HESSEN PROTOCOL STATUS FLAGS

Teledyne API's implementation of Hessen protocols includes a set of status bits that the instrument includes in responses to inform the host computer of its condition. Each bit can be assigned to one operational and warning message flag. The default settings for these bit/flags are:

Table 8-8: Default Hessen Status Flag Assignments

STATUS FLAG NAME	DEFAULT BIT ASSIGNMENT
WARNING FLAGS	
SAMPLE FLOW WARNING	0001
BENCH TEMP WARNING	0002
SOURCE WARNING	0004
BOX TEMP WARNING	0008
WHEEL TEMP WARNING	0010
SAMPLE TEMP WARN	0020
SAMPLE PRESS WARN	0040
INVALID CONC (The Instrument's Front Panel Display Will Show The Concentration As "Warnings")	0080
OPERATIONAL FLAGS[1]	
Instrument **OFF**	0100
In **MANUAL** Calibration Mode	0200
In **ZERO** Calibration Mode[4]	0400
In O_2 Calibration Mode (if O_2 sensor installed)[2,4]	0400
In CO_2 Calibration Mode (if CO_2 sensor installed)[2,4]	0400
In **SPAN** Calibration Mode	0800
UNITS OF MEASURE FLAGS	
UGM	0000
MGM	2000
PPB	4000
PPM	6000
SPARE/UNUSED BITS	1000, 8000
UNASSIGNED FLAGS (0000)	
AZERO WARN[2]	**DCPS WARNING**
CANNOT DYN SPAN[2]	**REAR BOARD NOT DET**
CANNOT DYN ZERO[3]	**SYNC WARNING**[1]
CONC ALARM 1[3]	**SYSTEM RESET**[1]
CONC ALARM 2[3]	

[1] These status flags are standard for all instruments and should probably not be modified.

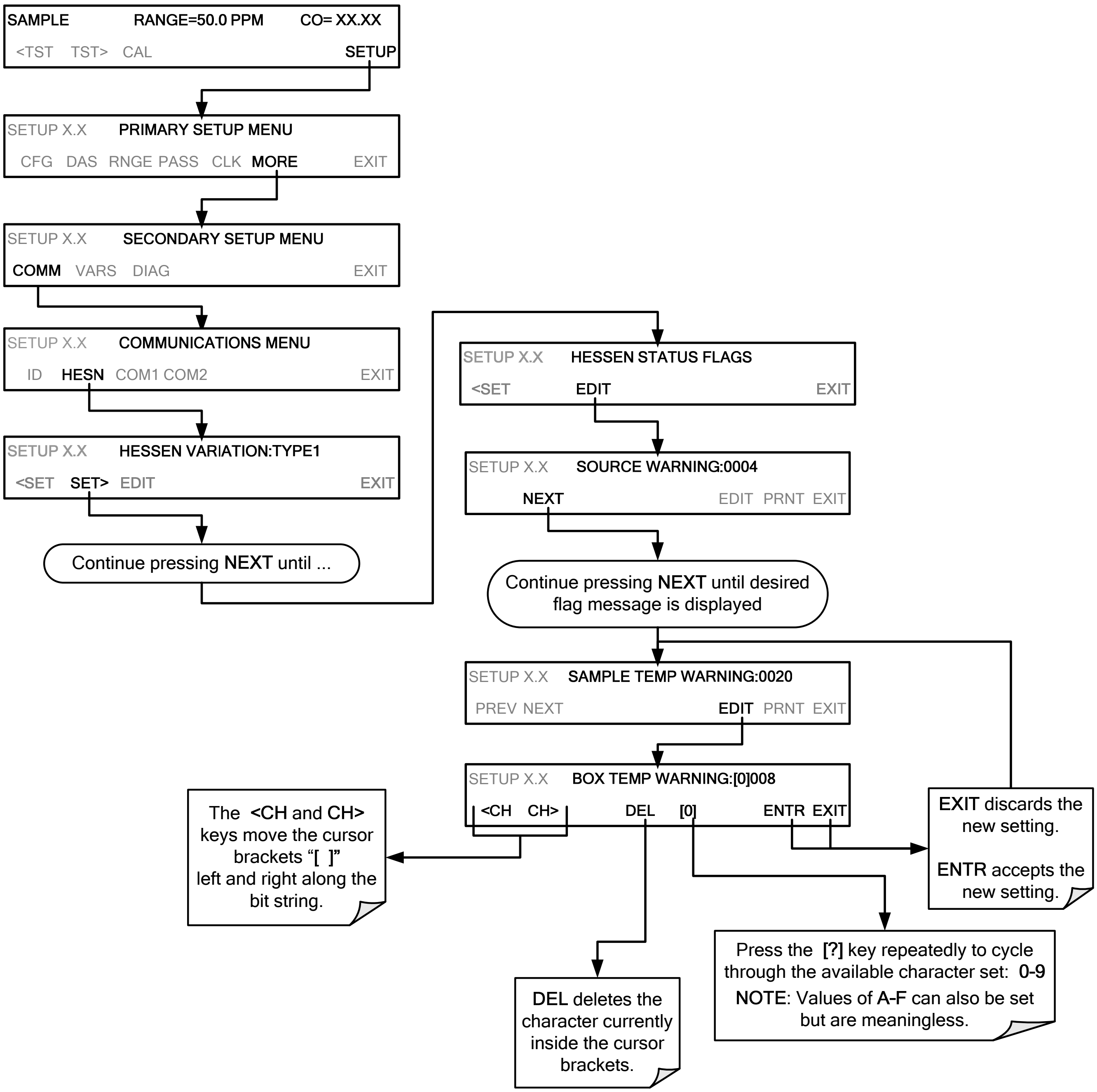
[2] Only applicable if the optional internal span gas generator is installed.

[3] Only applicable if the analyzer is equipped with an alarm options.

[3] It is possible to assign more than one flag to the same Hessen status bit. This allows the grouping of similar flags, such as all temperature warnings, under the same status bit.

Be careful not to assign conflicting flags to the same bit as each status bit will be triggered if any of the assigned flags is active.

To assign or reset the status flag bit assignments, press:



8.6.8. **INSTRUMENT ID CODE**

Each instrument on a Hessen Protocol network must have a unique ID code. If more than one M300E/EM Analyzer is on the Hessen network, you will have to change this code for all but one of the M300E/EM Analyzer’s on the Hessen network (see Section 8.1.6).

- The default **ID** code for the M300E/EM Analyzers is **300**.

8.7. APICOM REMOTE CONTROL PROGRAM

APICOM is an easy-to-use, yet powerful interface program that allows the user to access and control any of Teledyne API's main line of ambient and stack-gas instruments from a remote connection through direct cable, modem or Ethernet. Running APICOM, a user can:

- Establish a link from a remote location to the M300E/EM through direct cable connection via RS-232 modem or Ethernet.
- View the instrument's front panel and remotely access all functions that could be accessed when standing in front of the instrument.
- Remotely edit system parameters and set points.
- Download, view, graph and save data for predictive diagnostics or data analysis.
- Check on system parameters for trouble-shooting and quality control.

APICOM is very helpful for initial setup, data analysis, maintenance and troubleshooting. Figure 8-8 shows example of APICOM's main interface, which emulates the look and functionality of the instruments actual front panel.

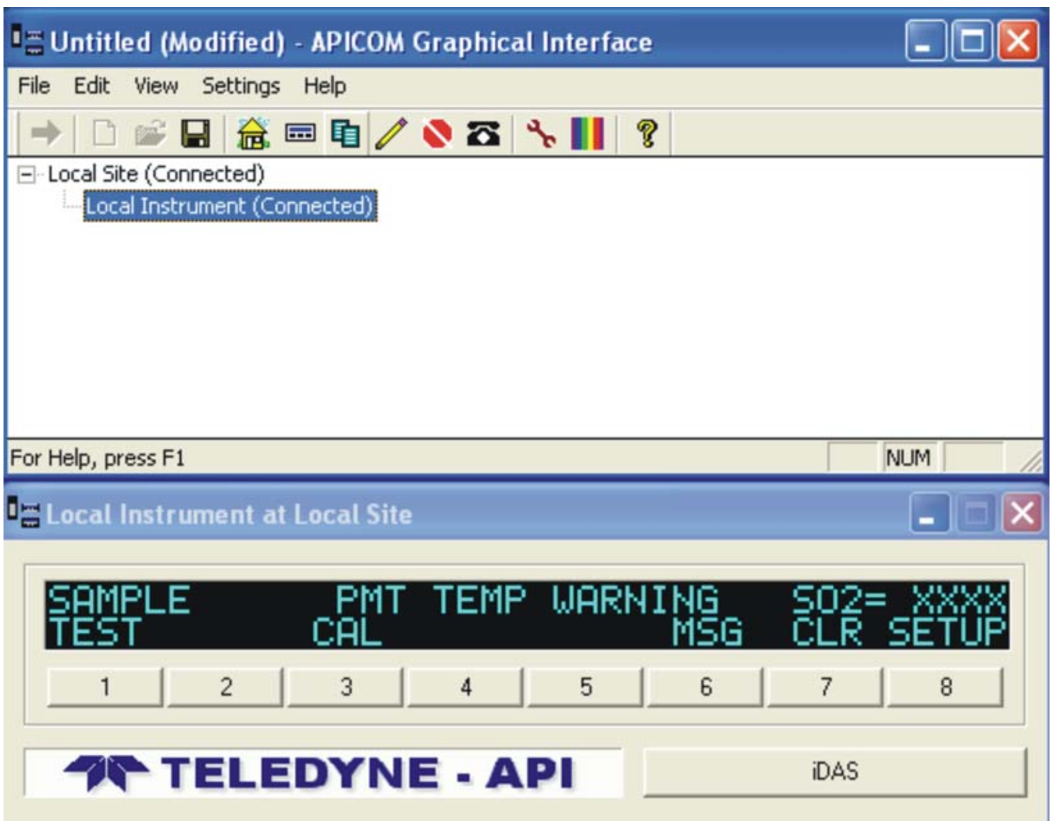


Figure 8-8: APICOM Remote Control Program Interface

> **NOTE**
> **APICOM is included free of cost with the analyzer and the latest versions can also be downloaded for free at http://www.teledyne-api.com/man**

9. CALIBRATION PROCEDURES

This section contains a variety of information regarding the various methods for calibrating a M300E/EM as well as other supporting information. For information on EPA protocol calibration, please refer to Section 10.

This section is organized as follows:

SECTION 9.1 – BEFORE CALIBRATION

This section contains general information you should know before about calibrating the analyzer.

SECTION 9.2– MANUAL CALIBRATION CHECKS AND CALIBRATION OF THE M300E/EM ANALYZER IN ITS BASE CONFIGURATION

This section describes the procedure for checking the calibrating of the M300E/EM and calibrating the instrument with no zero/span valves installed or if installed, not operating.

It requires that zero air and span gas is inlet through the SAMPLE port.

Also included are instructions for selecting the reporting range to be calibrated when the M300E/EM Analyzer is set to operate in either the DUAL or AUTO reporting range modes.

SECTION 9.3 – MANUAL CALIBRATION AND CAL CHECKS WITH VALVE OPTIONS INSTALLED

This section describes:

- The procedure for manually checking the calibration of the instrument with optional zero/span valves option installed.
- The procedure for manually calibrating the instrument with zero/span valves.
- Instructions on activating the zero/span valves via the control in contact closures of the analyzers external digital I/O.

SECTION 9.4 – AUTOMATIC ZERO/SPAN CAL/CHECK (AUTOCAL)

This section describes the procedure for using the AutoCal feature of the analyzer to check or calibrate the instrument.

- The AutoCal feature requires that either the zero/span valve option or the internal span gas generator option be installed and operating. NOTE: This practice is not approved by the US EPA.

SECTION 9.5 – CO CALIBRATION QUALITY ANALYSIS

This section describes how to judge the effectiveness of a recently performed calibration.

SECTION 9.6 – CALIBRATION OF M300E/EM ANALYZER'S ELECTRONIC SUBSYSTEMS

This section describes how to perform calibrations of the M300E/EM Analyzer's electronic systems, including:

- Dark Calibration of the optical bench.
- The pressure and flow sensors.

SECTION 9.7 – CALIBRATION OF OPTIONAL GAS SENSORS

This section describes how to perform calibrations of the various optional sensors available on the M300E/EM Analyzers, including:

- The O_2 Sensor, and;
- The CO_2 Sensor.

NOTE

Throughout this section are various diagrams showing pneumatic connections between the M300E/EM and various other pieces of equipment such as calibrators and zero air sources.

These diagrams are only intended to be schematic representations of these connections and do not reflect actual physical locations of equipment and fitting location or orientation.

Contact your regional EPA or other appropriate governing agency for more detailed recommendations.

9.1. BEFORE CALIBRATION

The calibration procedures in this section assume that the range mode, analog range and units of measure have already been selected for the analyzer. If this has not been done, please do so before continuing (see Section 6.6 for instructions).

> **NOTE**
>
> **If any problems occur while performing the following calibration procedures, refer to Section 12 for troubleshooting tips.**

9.1.1. REQUIRED EQUIPMENT, SUPPLIES, AND EXPENDABLES

Calibration of the M300E/EM Analyzer requires a certain amount of equipment and supplies. These include, but are not limited to, the following:

- Zero-air source.
- Span gas source.
- Gas lines - All Gas lines should be PTFE (Teflon), FEP, glass, stainless steel or brass.
- A recording device such as a strip-chart recorder and/or data logger (optional). For electronic documentation, the internal data acquisition system iDAS can be used.

> **NOTE**
>
> **If any problems occur while performing the following calibration procedures, refer to Section 12 of this manual for troubleshooting tips.**

9.1.2. CALIBRATION GASES

9.1.2.1. Zero Air

Zero air or zero calibration gas is defined as a gas that is similar in chemical composition to the measured medium but without the gas to be measured by the analyzer.

For the M300E/EM zero air should contain less than 25 ppb of CO and other major interfering gases such as CO and Water Vapor. It should have a dew point of -5°C or less.

If your application is not a measurement in ambient air, the zero calibration gas should be matched to the composition of the gas being measured.

- Pure nitrogen (N_2) can be used as a zero gas for applications where CO is measured in nitrogen.
- If your analyzer is equipped with an external zero air scrubber option, it is capable of creating zero air from ambient air.

For analyzers without the zero air scrubber, a zero air generator such as the Teledyne API's M701 can be used. Please visit the company website for more information.

9.1.2.2. **Span Gas**

Span Gas is a gas specifically mixed to match the chemical composition of the type of gas being measured at near full scale of the desired measurement range. It is recommended that the span gas used have a concentration equal to 80-90% of the full measurement range. If Span Gas is sourced directly from a calibrated, pressurized tank, the gas mixture should be CO mixed with Zero Air or N_2 at the required ratio.

For oxygen measurements using the optional O_2 sensor, we recommend a reference gas of 21% O_2 in N_2.

- For quick checks, ambient air can be used at an assumed concentration of 20.8%.
- Generally, O_2 concentration in dry, ambient air varies by less than 1%.

9.1.2.3. **Traceability**

All equipment used to produce calibration gases should be verified against standards of the National Institute for Standards and Technology (NIST). To ensure NIST traceability, we recommend to acquire cylinders of working gas that are certified to be traceable to NIST Standard Reference Materials (SRM). These are available from a variety of commercial sources.

Table 9-1: NIST-SRMs Available for Traceability of CO Calibration Gases

NIST-SRM	TYPE	NOMINAL CONCENTRATION
1680b	CO in N_2	500 ppm
1681b	CO in N_2	1000 ppm
2613a	CO in Zero Air	20 ppm
2614a	CO in Zero Air	45 ppm
2659a[1]	O_2 in N_2	21% by weight
2626a	CO_2 in N_2	4% by weight
2745[2]	CO_2 in N_2	16% by weight

[1] Used to calibrate optional O_2 sensor.
[2] Used to calibrate optional CO_2 sensor.

> **NOTE**
>
> **It is generally a good idea to use 80% of the reporting range for that channel for the span point calibration.**
>
> **For instance if the reporting range of the instrument is set for 50.0 PPM, the proper span gas would be 40.0 PPM**

9.1.3. **DATA RECORDING DEVICES**

A strip chart recorder, data acquisition system or digital data acquisition system should be used to record data from the serial or analog outputs of the M300E/EM.

- If analog readings are used, the response of the recording system should be checked against a NIST traceable voltage source or meter.
- Data recording devices should be capable of bi-polar operation so that negative readings can be recorded.
- For electronic data recording, the M300E/EM provides an internal data acquisition system (iDAS), which is described in detail in Section 7.1

APICOM, a remote control program, is also provided as a convenient and powerful tool for data handling, download, storage, quick check and plotting (see Section 8.4).

9.2. MANUAL CALIBRATION CHECKS AND CALIBRATION OF THE M300E/EM ANALYZER IN ITS BASE CONFIGURATION

ZERO/SPAN CALIBRATION CHECKS VS. ZERO/SPAN CALIBRATION

Pressing the ENTR key during the following procedure resets the stored values for OFFSET and SLOPE and alters the instrument's Calibration.

This should ONLY BE DONE during an actual calibration of the M300E/EM.

NEVER press the ENTR key if you are only checking calibration.

9.2.1. SETUP FOR BASIC CALIBRATION CHECKS AND CALIBRATION

STEP ONE: Connect the Sources of Zero Air and Span Gas as shown below.

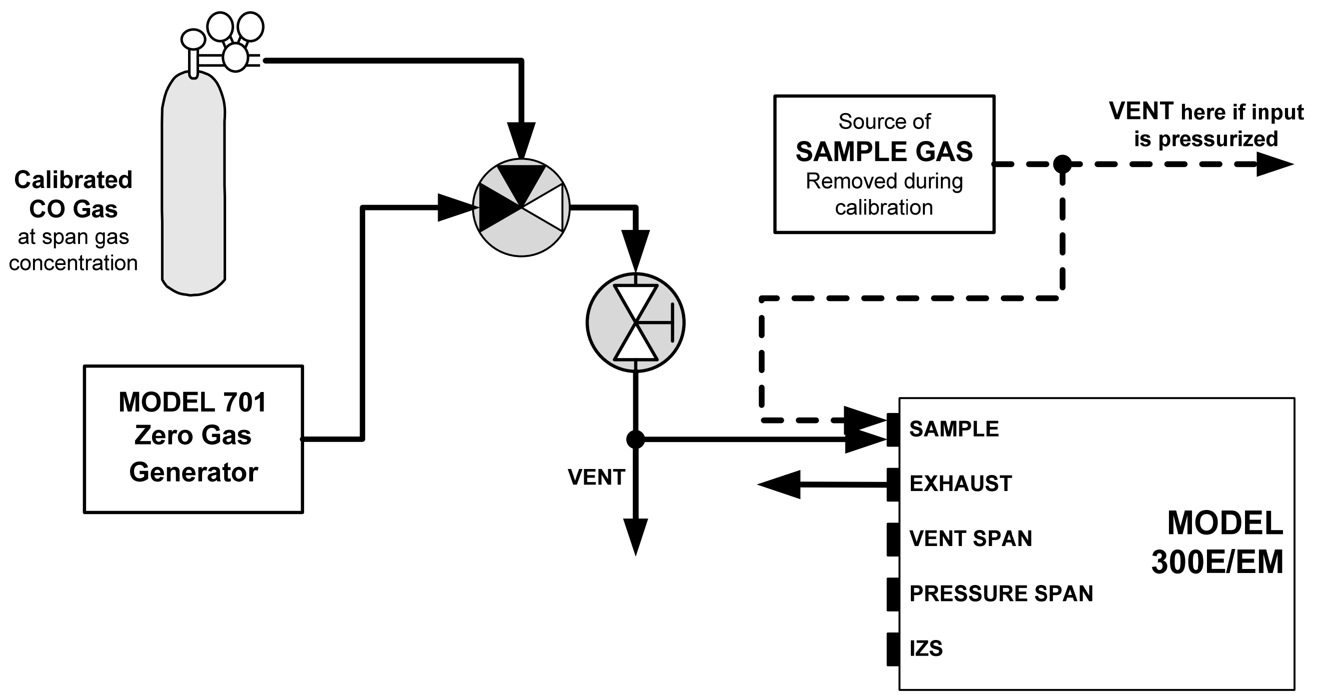


Figure 9-1: Pneumatic Connections – Basic Configuration – Using Bottled Span Gas

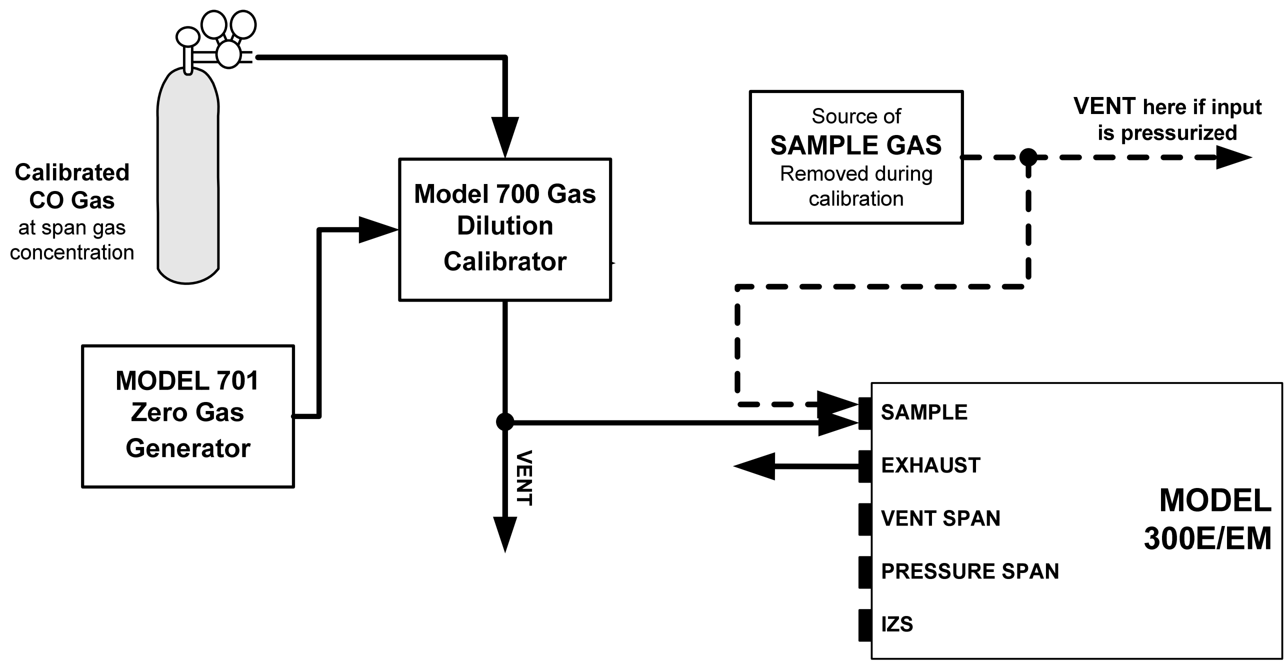
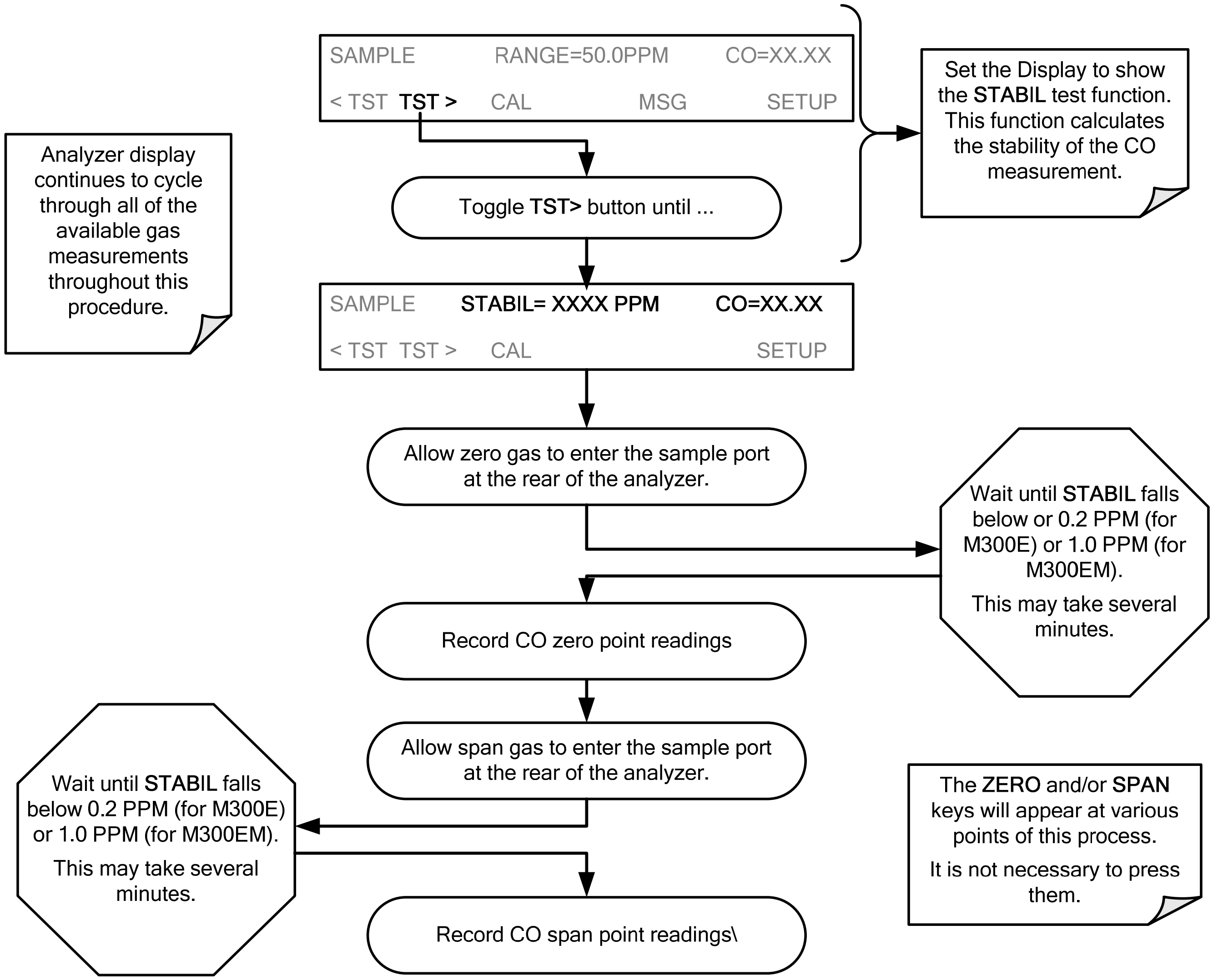


Figure 9-2: Pneumatic Connections – Basic Configuration – Using Gas Dilution Calibrator

9.2.2. **PERFORMING A BASIC MANUAL CALIBRATION CHECK**



NOTE

If the ZERO or SPAN keys are not displayed, the measurement made during is out of the allowable range allowed for a reliable calibration.

See Section 12 for troubleshooting tips.

9.2.3. PERFORMING A BASIC MANUAL CALIBRATION

The following section describes the basic method for manually calibrating the M300E/EM.

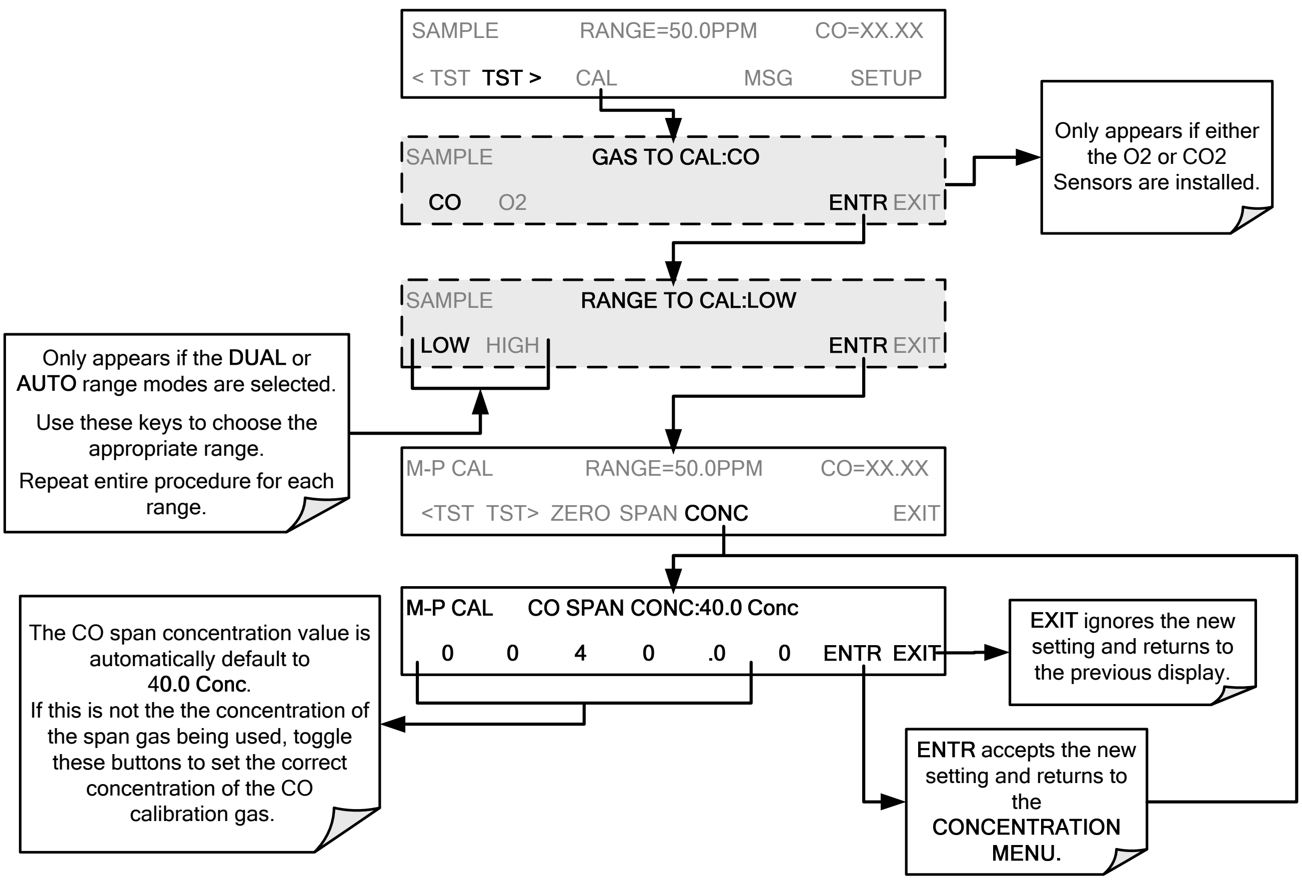
If the analyzer's reporting range is set for the **AUTO** range mode, a step will appear for selecting which range is to be calibrated (**LOW** or **HIGH**). Each of these two ranges **MUST** be calibrated separately.

9.2.3.1. Setting the Expected Span Gas Concentration

NOTE
When setting expected concentration values, consider impurities in your span gas.

The expected CO span gas concentration should be 80% of the reporting range of the instrument (see Section 6.6.1).

The default factory setting is 40 ppm. To set the span gas concentration, press:

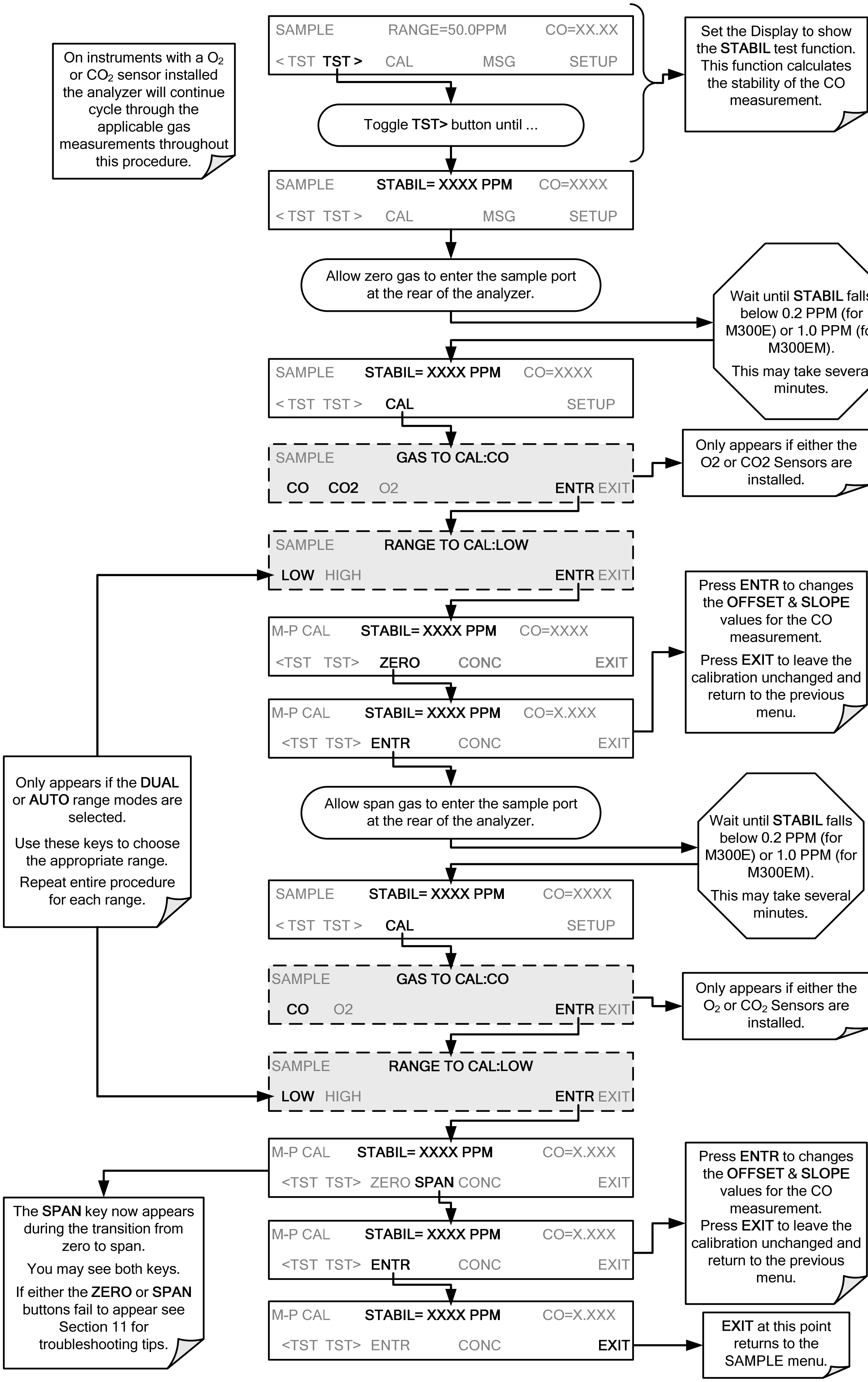


NOTE

For this Initial Calibration it is important to independently verify the PRECISE CO Concentration Value of the SPAN gas.

If the source of the Span Gas is from a Calibrated Bottle, use the exact concentration value printed on the bottle.

9.2.3.2. **Zero/Span Point Calibration Procedure**



9.3. MANUAL CALIBRATION WITH ZERO/SPAN VALVES

There are a variety of valve options available on the M300E/EM for handling calibration gases (see Section 5.6 for descriptions of each).

Generally performing calibration checks and zero/span point calibrations on analyzers with these options installed is similar to the methods discussed in the previous sections of this section. The primary differences are:

- On instruments with Z/S valve options, zero air and span gas is supplied to the analyzer through other gas inlets besides the sample gas inlet.
- The zero and span calibration operations are initiated directly and independently with dedicated keys (**CALZ** & **CALS**).

9.3.1. SETUP FOR CALIBRATION USING VALVE OPTIONS

Each of the various calibration valve options requires a different pneumatic setup that is dependent on the exact nature and number of valves present.

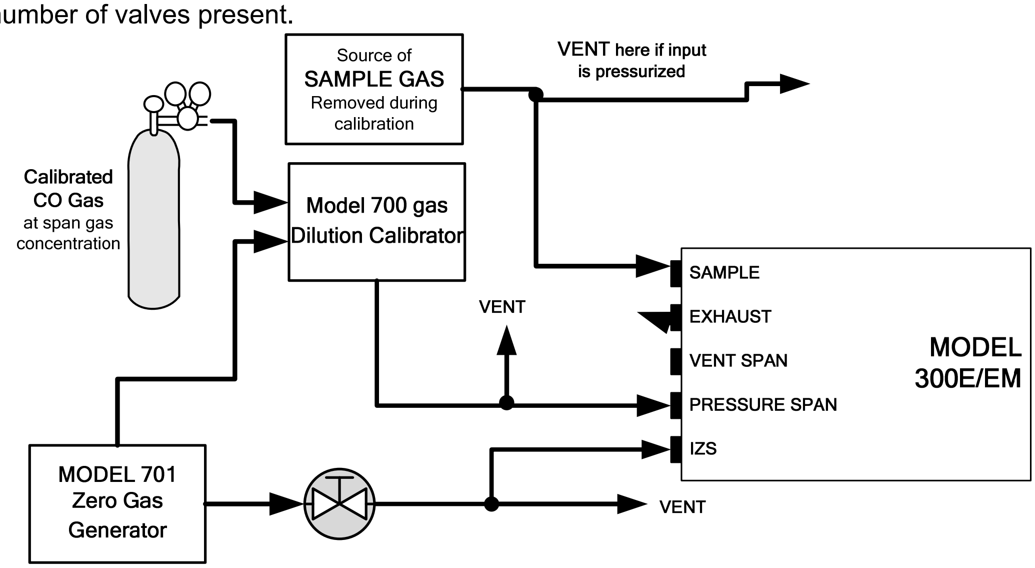


Figure 9-3: Pneumatic Connections – Option 50A: Zero/Span Calibration Valves

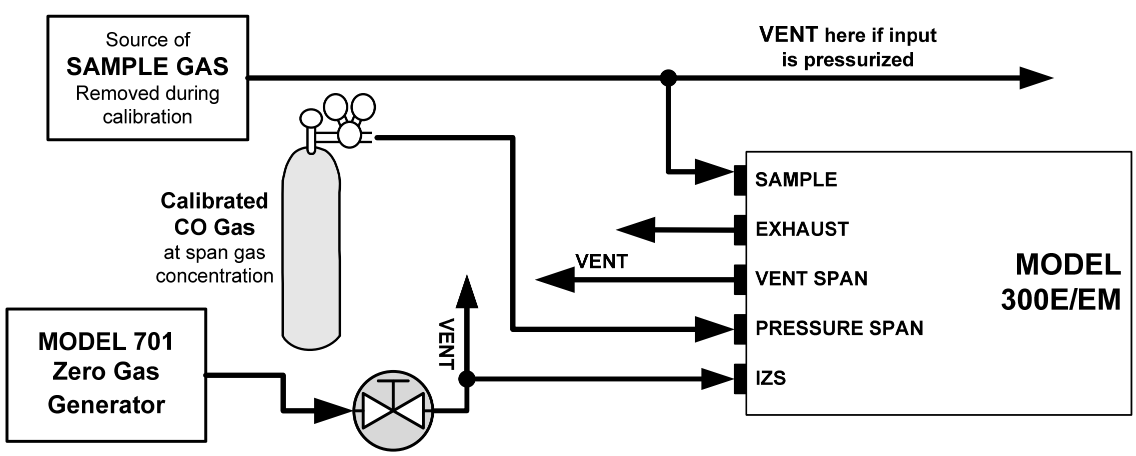


Figure 9-4: Pneumatic Connections – Option 50B: Zero/Pressurized Span Calibration Valves

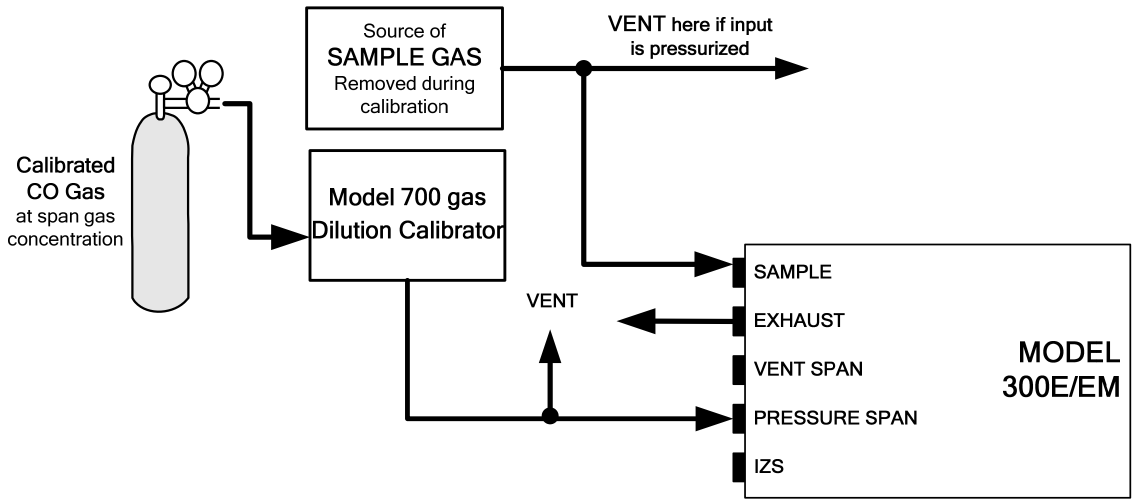


Figure 9-5: Pneumatic Connections – Option 51B: Zero/Span Calibration Valves

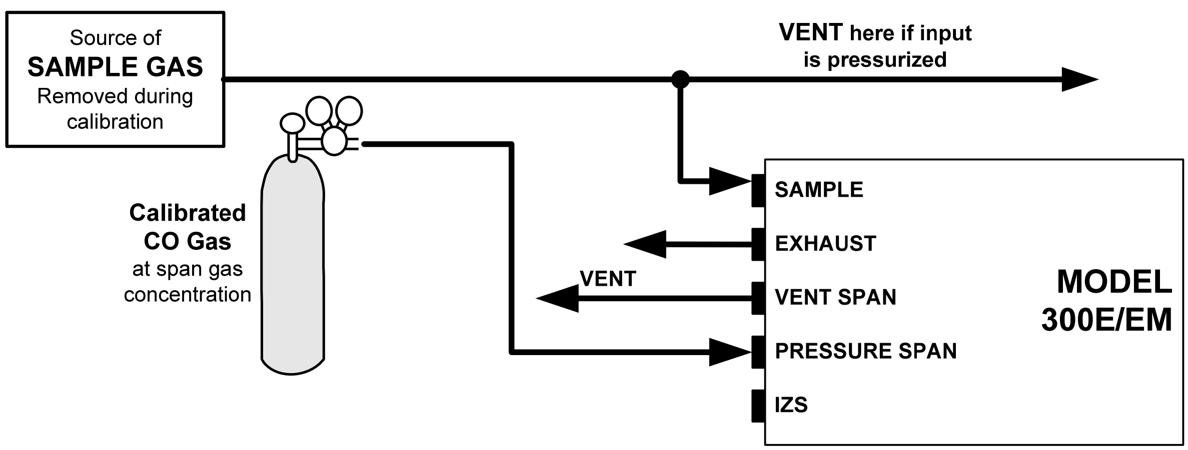
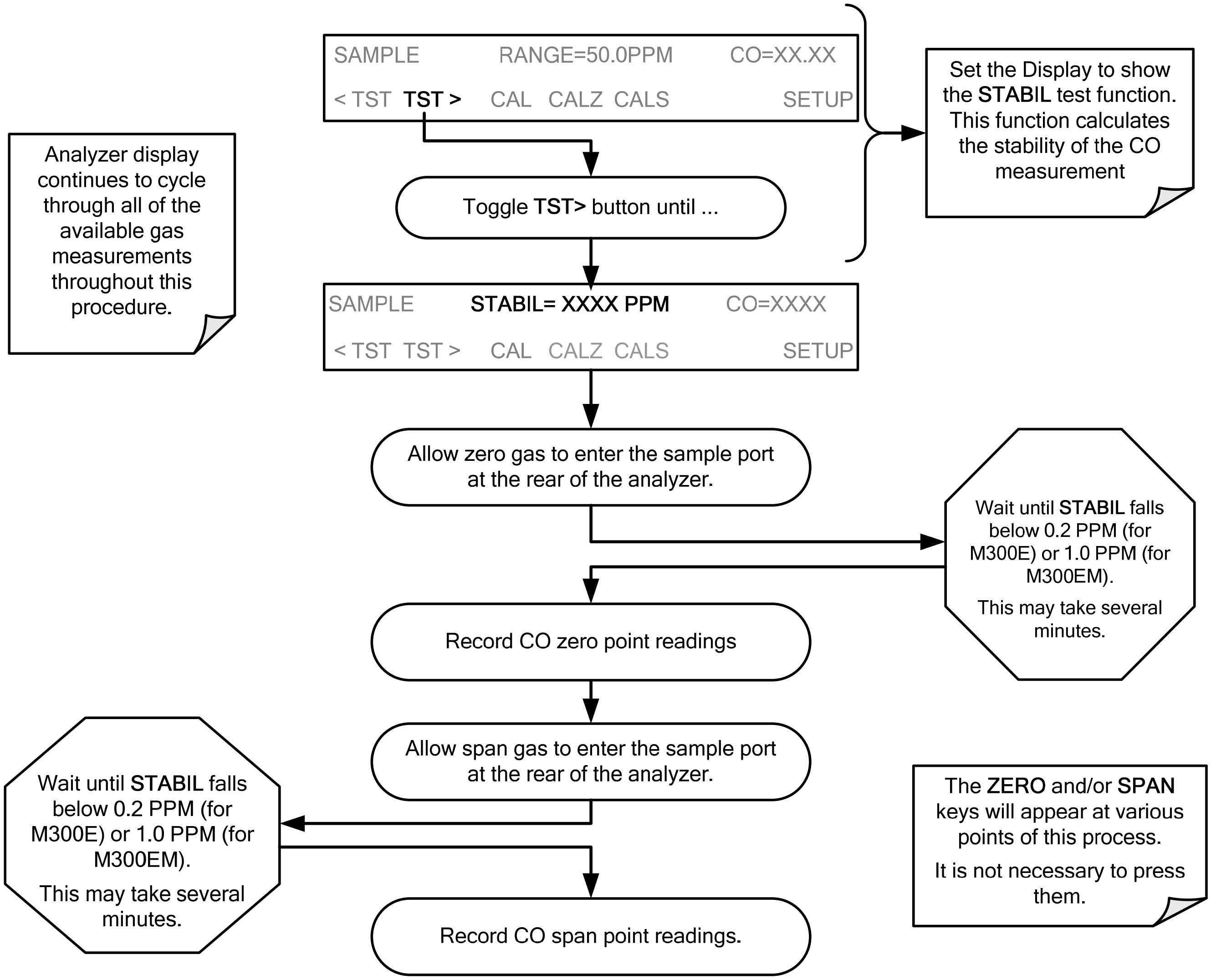


Figure 9-6: Pneumatic Connections – Option 51C: Zero/Span Calibration Valves

9.3.2. MANUAL CALIBRATION CHECKS WITH VALVE OPTIONS INSTALLED



9.3.3. MANUAL CALIBRATION USING VALVE OPTIONS

The following section describes the basic method for manually calibrating the M300E/EM Analyzer.

If the analyzer's reporting range is set for the **DUAL** or **AUTO** range modes, a step will appear for selecting which range is to be calibrated (**LOW** or **HIGH**).

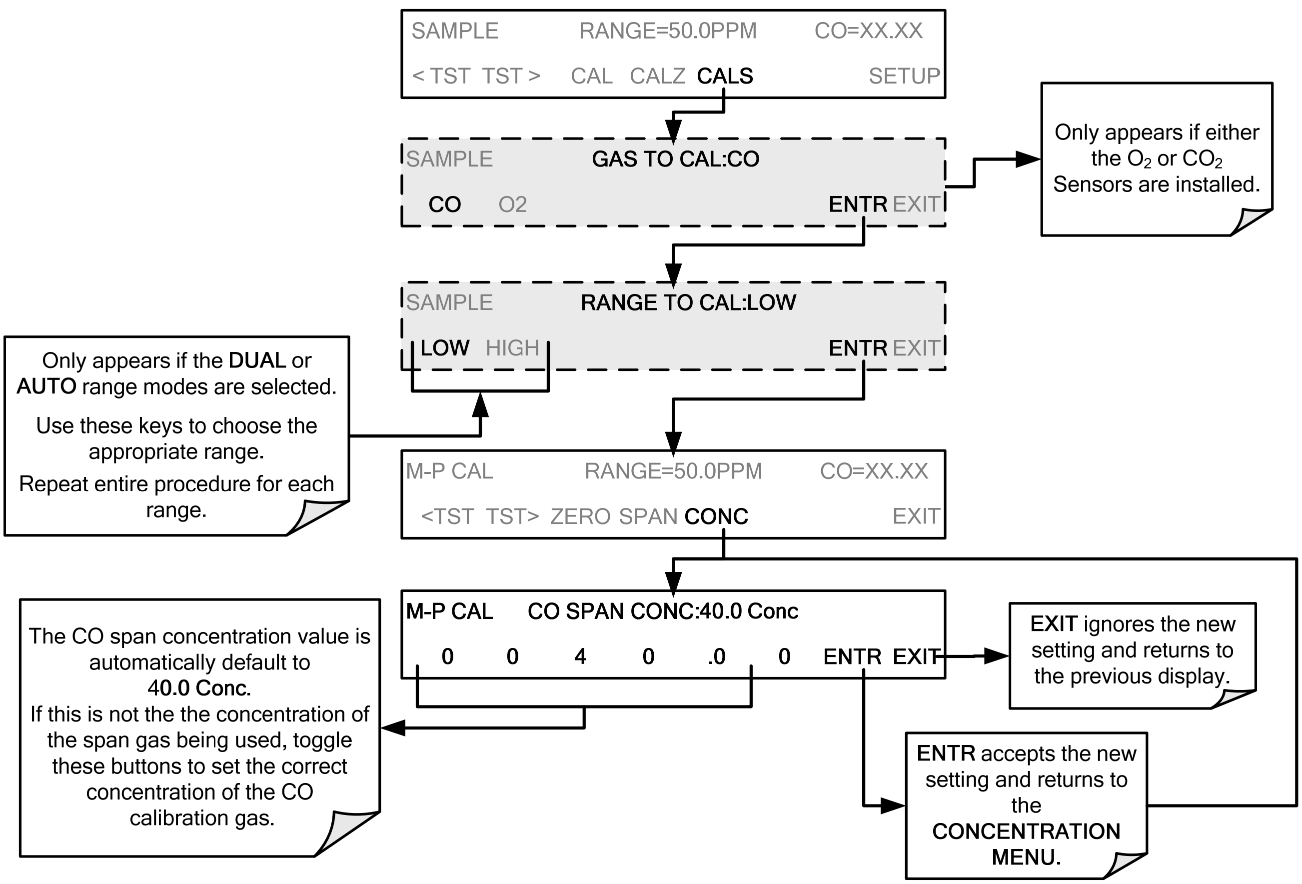
Each of these two ranges **MUST** be calibrated separately.

9.3.3.1. Setting the Expected Span Gas Concentration

NOTE
When setting expected concentration values, consider impurities in your span gas.

The expected CO span gas concentration should be 80% of the reporting range of the instrument (see Section 6.6.1). The default factory setting is 40 ppm.

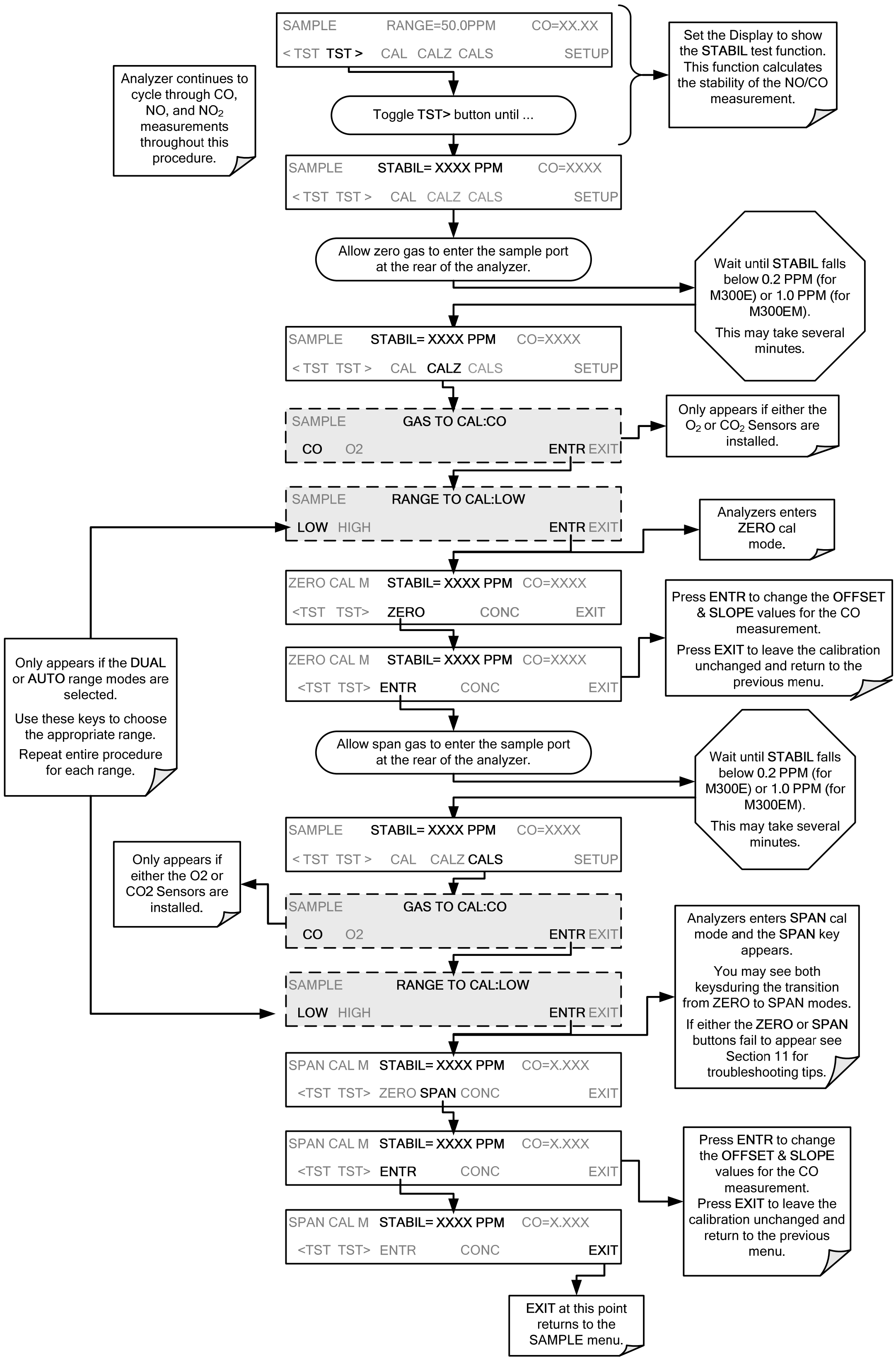
To set the span gas concentration, press:



NOTE
For this Initial Calibration it is important to independently verify the PRECISE CO Concentration Value of the SPAN gas.
If the source of the Span Gas is from a Calibrated Bottle, use the exact concentration value printed on the bottle.

9.3.3.2. **Zero/Span Point Calibration Procedure**

The zero and cal operations are initiated directly and independently with dedicated keys (**CALZ** & **CALS**).



9.3.3.3. **Use of Zero/Span Valve with Remote Contact Closure**

Contact closures for controlling calibration and calibration checks are located on the rear panel **CONTROL IN** connector. Instructions for setup and use of these contacts can be found in Section 3.3.4.

When the appropriate contacts are closed for at least 5 seconds, the instrument switches into zero, or span calibration mode and any internal zero/span valves installed will be automatically switched to the appropriate configuration.

- The remote calibration contact closures may be activated in any order.
- It is recommended that contact closures remain closed for at least 10 minutes to establish a reliable reading.
- The instrument will stay in the selected mode for as long as the contacts remain closed.

If contact closures are being used in conjunction with the analyzer's AutoCal (see Section 9.4) feature and the AutoCal attribute "**CALIBRATE"** is enabled, the M300E/EM will not recalibrate the analyzer until the contact is opened. At this point, the new calibration values will be recorded before the instrument returns to **Sample Mode**.

If the AutoCal attribute "**CALIBRATE"** is disabled, the instrument will return to **Sample Mode**, leaving the instrument's internal calibration variables unchanged.

9.4. **AUTOMATIC ZERO/SPAN CAL/CHECK (AUTOCAL)**

The AutoCal system allows unattended periodic operation of the Z**ERO/SPAN** valve options by using the M300E/EM Analyzer's internal time of day clock. AutoCal operates by executing **SEQUENCES** programmed by the user to initiate the various calibration modes of the analyzer and open and close valves appropriately. It is possible to program and run up to three separate sequences (**SEQ1**, **SEQ2** and **SEQ3**). Each sequence can operate in one of three modes, or be disabled.

Table 9-2: AUTOCAL Modes

MODE NAME	ACTION
DISABLED	Disables the Sequence.
ZERO	Causes the Sequence to perform a Zero calibration/check.
ZERO-SPAN	Causes the Sequence to perform a Zero point calibration/check followed by a Span point calibration/check.
SPAN	Causes the Sequence to perform a Span concentration calibration/check only.

For each mode, there are seven parameters that control operational details of the SEQUENCE (see Table 9-3).

Table 9-3: AutoCal Attribute Setup Parameters

ATTRIBUTE	ACTION
TIMER ENABLED	Turns on the Sequence timer.
STARTING DATE	Sequence will operate after Starting Date.
STARTING TIME	Time of day sequence will run.
DELTA DAYS	Number of days to skip between each Sequence execution. • If set to 7, for example, the AutoCal feature will be enabled once every week on the same day.
DELTA TIME	Number of hours later each “Delta Days” Seq is to be run. • If set to 0, the sequence will start at the same time each day. **Delta Time** is added to **Delta Days** for the total time between cycles. • This parameter prevents the analyzer from being calibrated at the same daytime of each calibration day and prevents a lack of data for one particular daytime on the days of calibration.
DURATION	Number of minutes the sequence operates. • This parameter needs to be set such that there is enough time for the concentration signal to stabilize. • The STB parameter shows if the analyzer response is stable at the end of the calibration. • This parameter is logged with calibration values in the iDAS.
CALIBRATE	Enable to do a calibration – Disable to do a cal check only. • This setting must be OFF for analyzers used in US EPA applications and with internal span gas generators installed and functioning.
RANGE TO CAL	LOW calibrates the low range, HIGH calibrates the high range. Applies only to auto and remote range modes; this property is not available in single and independent range modes.

NOTE

The CALIBRATE attribute (formerly called “dynamic calibration”) must always be set to OFF for analyzers used in US EPA controlled applications that have internal span gas generators option installed.

Calibration of instruments used in US EPA related applications should only be performed using external sources of zero air and span gas with an accuracy traceable to EPA or NIST standards and supplied through the analyzer’s sample port.

The following example sets sequence #2 to do a zero-span calibration every other day starting at 2:15 PM on September 4, 2008, lasting 15 minutes, without calibration. This will start ½ hour later each iteration.

Table 9-4: Example AutoCal Sequence

MODE AND ATTRIBUTE	VALUE	COMMENT
SEQUENCE	2	Define Sequence #2
MODE	ZERO-SPAN	Select Zero and Span Mode
TIMER ENABLE	ON	Enable the timer
STARTING DATE	Sept. 4, 2008	Start after Sept 4, 2008
STARTING TIME	14:15	First Span starts at 2:15 PM
DELTA DAYS	2	Do Sequence #2 every other day
DELTA TIME	00:30	Do Sequence #2 ½ hr later each day
DURATION	30.0	Operate Span valve for 15 min
CALIBRATE	ON	Calibrate at end of Sequence

NOTE

The programmed STARTING_TIME must be a minimum of 5 minutes later than the real time clock for setting real time clock (See Section 6.5.4).

Avoid setting two or more sequences at the same time of the day. Any new sequence that is initiated whether from a timer, the COM ports or the contact closure inputs will override any sequence that is in progress.

NOTE

With CALIBRATE turned ON, the state of the internal setup variables DYN_SPAN and DYN_ZERO is set to ON and the instrument will reset the slope and offset values for the CO response each time the AutoCal program runs.

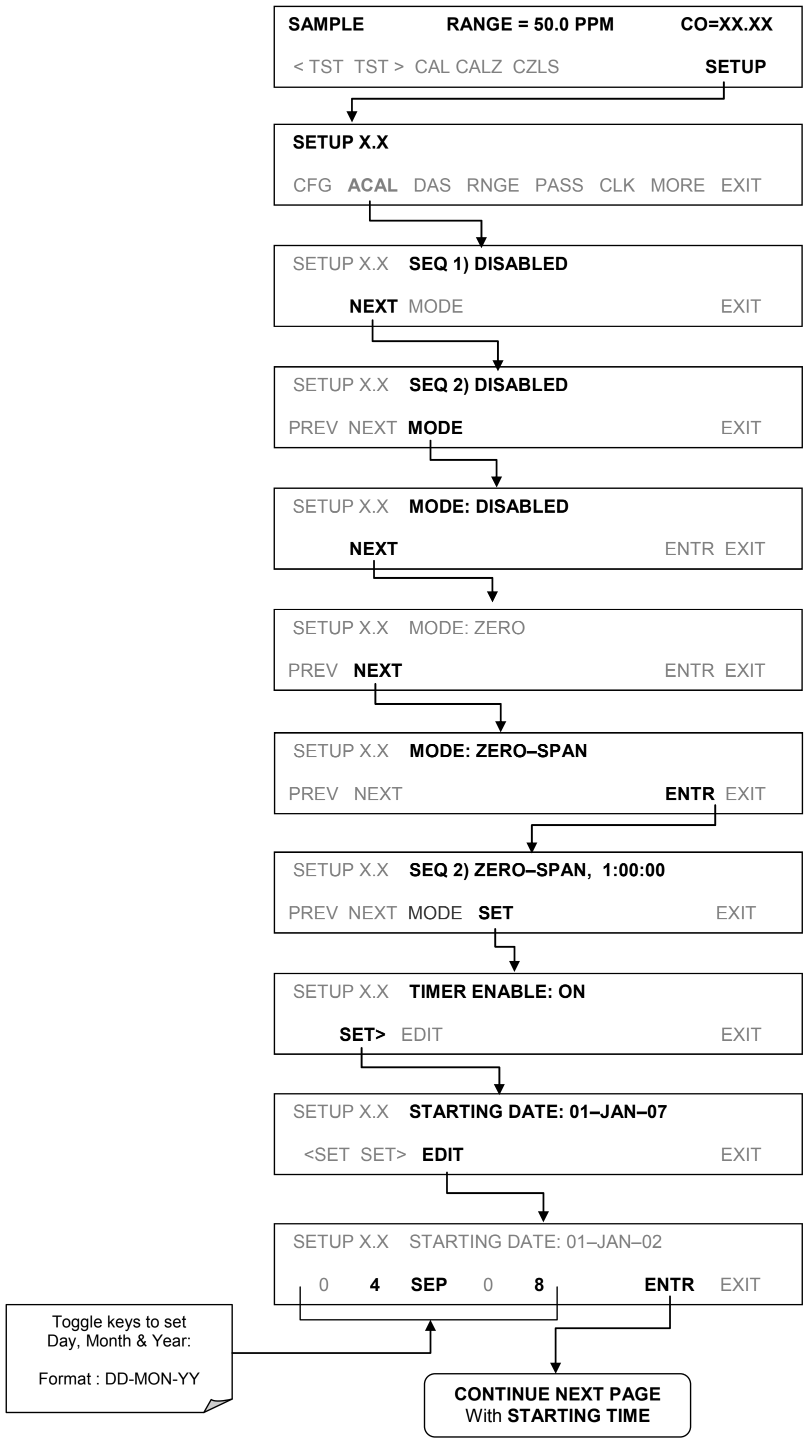
This continuous readjustment of calibration parameters can often mask subtle fault conditions in the analyzer. It is recommended that, if CALIBRATE is enabled, the analyzer's test functions, slope and offset values be checked frequently to assure high quality and accurate data from the instrument.

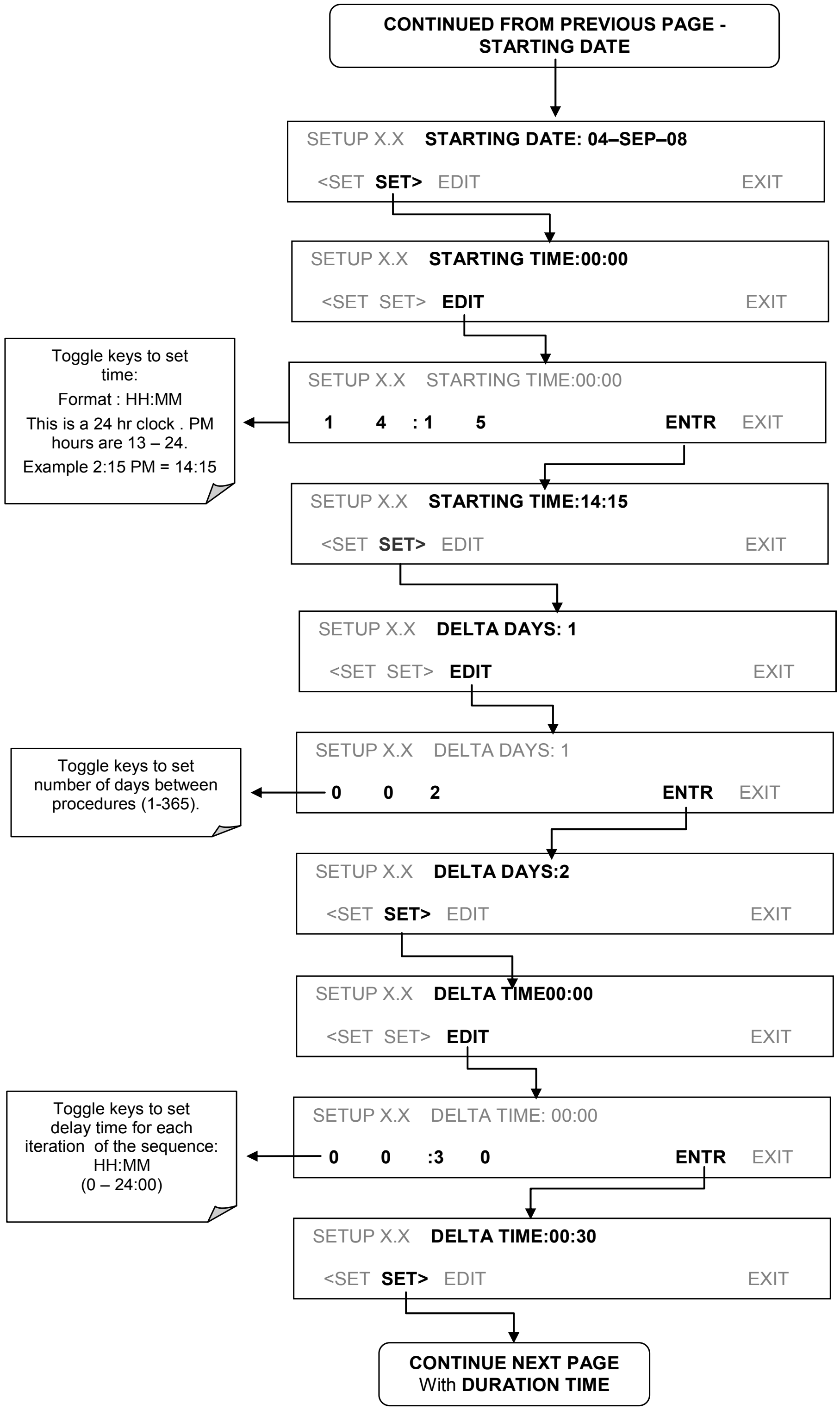
9.4.1. SETUP → ACAL: PROGRAMMING AND AUTO CAL SEQUENCE

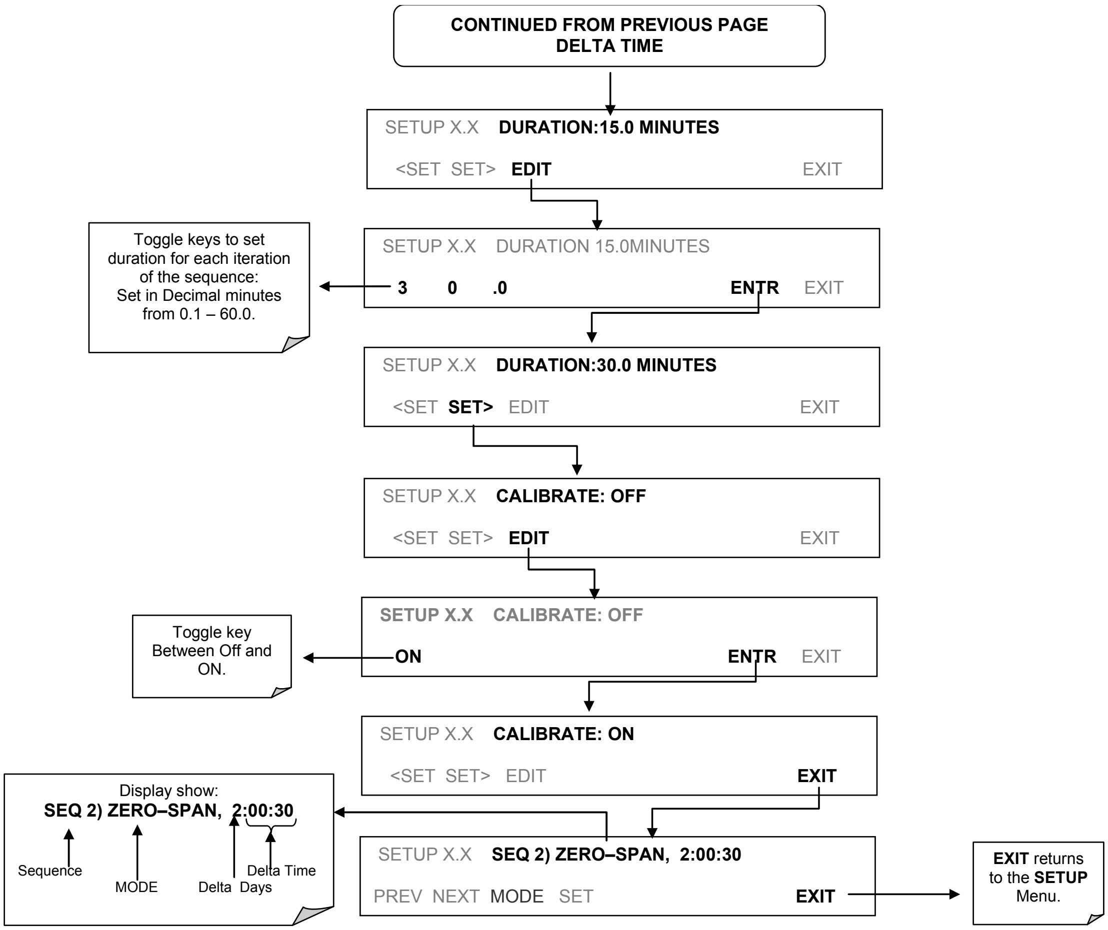
NOTE

If at any time an illegal entry is selected, (for example: Delta Days > 366) the ENTR key will disappear from the display.

To program the example sequence shown in Table 9-4, press:

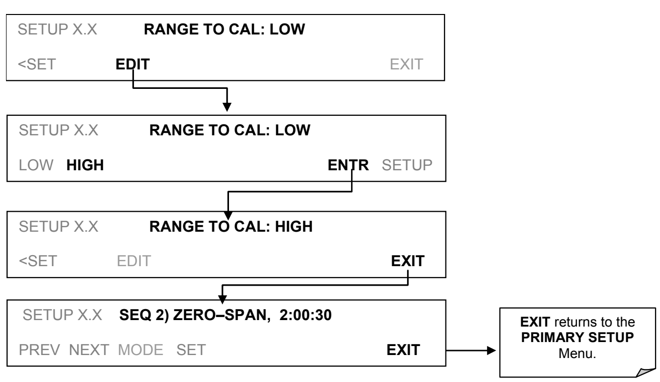



CONTINUED FROM PREVIOUS PAGE - STARTING DATE
SETUP X.X STARTING DATE: 04–SEP–08
<SET SET> EDIT EXIT
SETUP X.X STARTING TIME:00:00
<SET SET> EDIT EXIT
Toggle keys to set time:
Format : HH:MM
This is a 24 hr clock . PM hours are 13 – 24.
Example 2:15 PM = 14:15
SETUP X.X STARTING TIME:00:00
1 4 : 1 5 ENTR EXIT
SETUP X.X STARTING TIME:14:15
<SET SET> EDIT EXIT
SETUP X.X DELTA DAYS: 1
<SET SET> EDIT EXIT
Toggle keys to set number of days between procedures (1-365).
SETUP X.X DELTA DAYS: 1
0 0 2 ENTR EXIT
SETUP X.X DELTA DAYS:2
<SET SET> EDIT EXIT
SETUP X.X DELTA TIME00:00
<SET SET> EDIT EXIT
Toggle keys to set delay time for each iteration of the sequence: HH:MM (0 – 24:00)
SETUP X.X DELTA TIME: 00:00
0 0 :3 0 ENTR EXIT
SETUP X.X DELTA TIME:00:30
<SET SET> EDIT EXIT
CONTINUE NEXT PAGE With DURATION TIME



9.4.1.1. AutoCal with Auto or Dual Reporting Ranges Modes Selected

If the M300E/EM Analyzer is set for either the Dual or Auto reporting range modes, the following three steps will appear at the beginning of the AutoCal setup routine:



NOTE

In order to automatically calibrate both the HIGH and LOW ranges, you must set up a separate sequence for each.

9.5. CO CALIBRATION QUALITY

After completing one of the calibration procedures described above, it is important to evaluate the analyzer's calibration **SLOPE** and **OFFSET** parameters. These values describe the linear response curve of the analyzer. The values for these terms, both individually and relative to each other, indicate the quality of the calibration.

To perform this quality evaluation, you will need to record the values of both test functions (see Section 3.5.4 or Appendix A-3), all of which are automatically stored in the iDAS channel CALDAT for data analysis, documentation and archival.

Make sure that these parameters are within the limits listed below and frequently compare them to those values on the *Final Test and Validation Sheet* that came attached to your manual, which should not be significantly different. If they are, refer to the troubleshooting Section 12.

Table 9-5: Calibration Data Quality Evaluation

FUNCTION	MINIMUM VALUE	OPTIMUM VALUE	MAXIMUM VALUE
SLOPE	0.700	1.000	1.300
OFFS	-0.500	0.000	0.500
These values should not be significantly different from the values recorded on the Teledyne API's *Final Test and Validation Data Sheet* that was shipped with your instrument. If they are, refer to the troubleshooting Section 12.			

The default iDAS configuration records all calibration values in channel **CALDAT** as well as all calibration check (zero and span) values in its internal memory.

- Up to 200 data points are stored for up to 4 years of data (on weekly calibration checks) and a lifetime history of monthly calibrations.
- Review these data to see if the zero and span responses change over time.
- These channels also store the **STABIL** value (standard deviation of CO concentration) to evaluate if the analyzer response has properly leveled off during the calibration procedure.
- Finally, the **CALDAT** channel also stores the converter efficiency for review and documentation.

If your instrument has either an O_2 or CO_2 sensor option installed these should be calibrated as well.

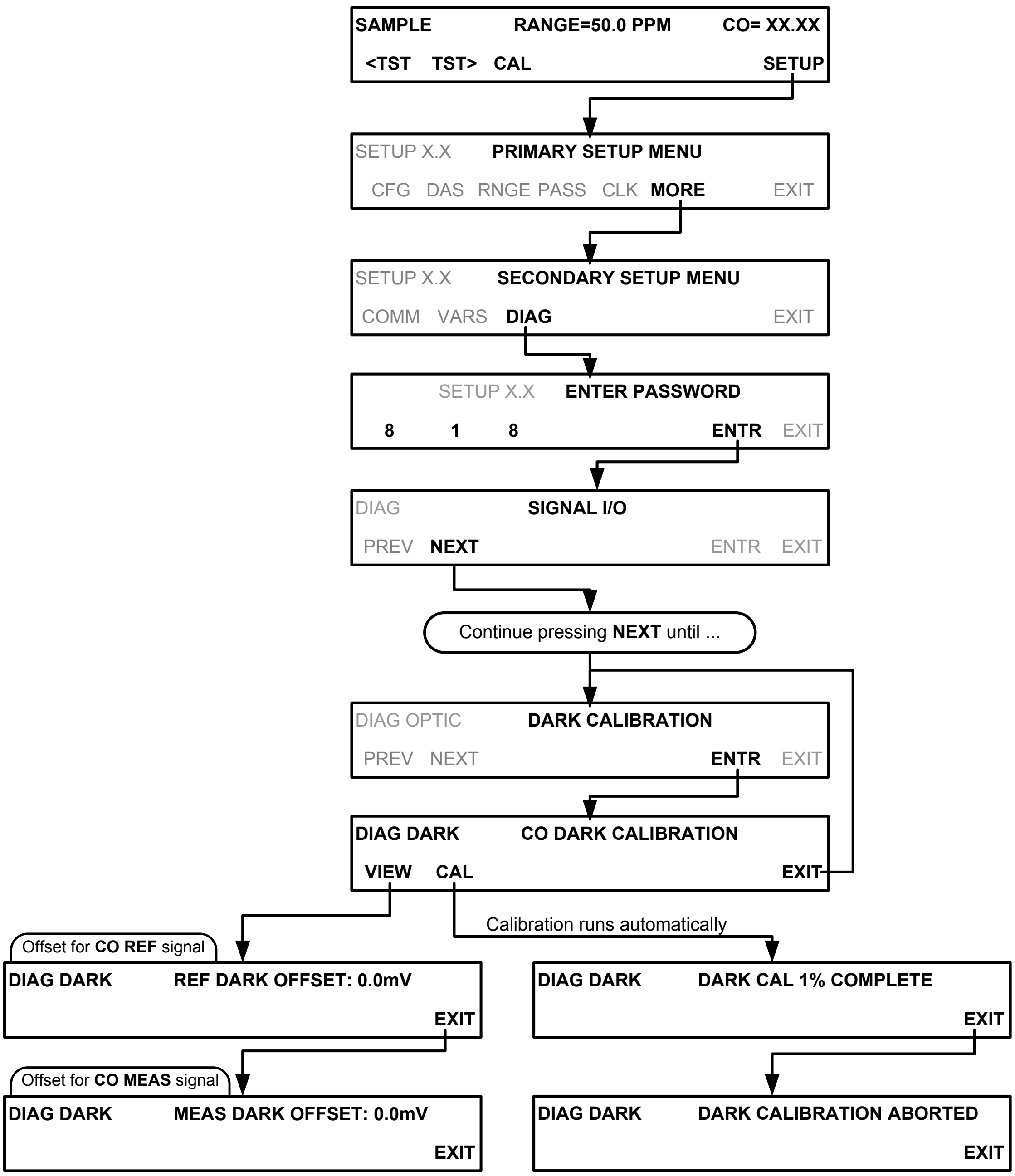
9.6. CALIBRATION OF THE M300E/EM'S ELECTRONIC SUBSYSTEMS

9.6.1. DARK CALIBRATION TEST

The dark calibration test interrupts the signal path between the IR photo-detector and the remainder of the sync/demod board circuitry. This allows the instrument to compensate for any voltage levels inherent in the sync/demod circuitry that might effect the calculation of CO concentration.

Performing this calibration returns two offset voltages, one for **CO MEAS** and one for **CO REF** that are automatically added to the CPU's calculation routine. The two offset voltages from the last calibration procedure may be reviewed by the user via the front panel display.

To activate the dark calibration procedure or review the results of a previous calibration, press:

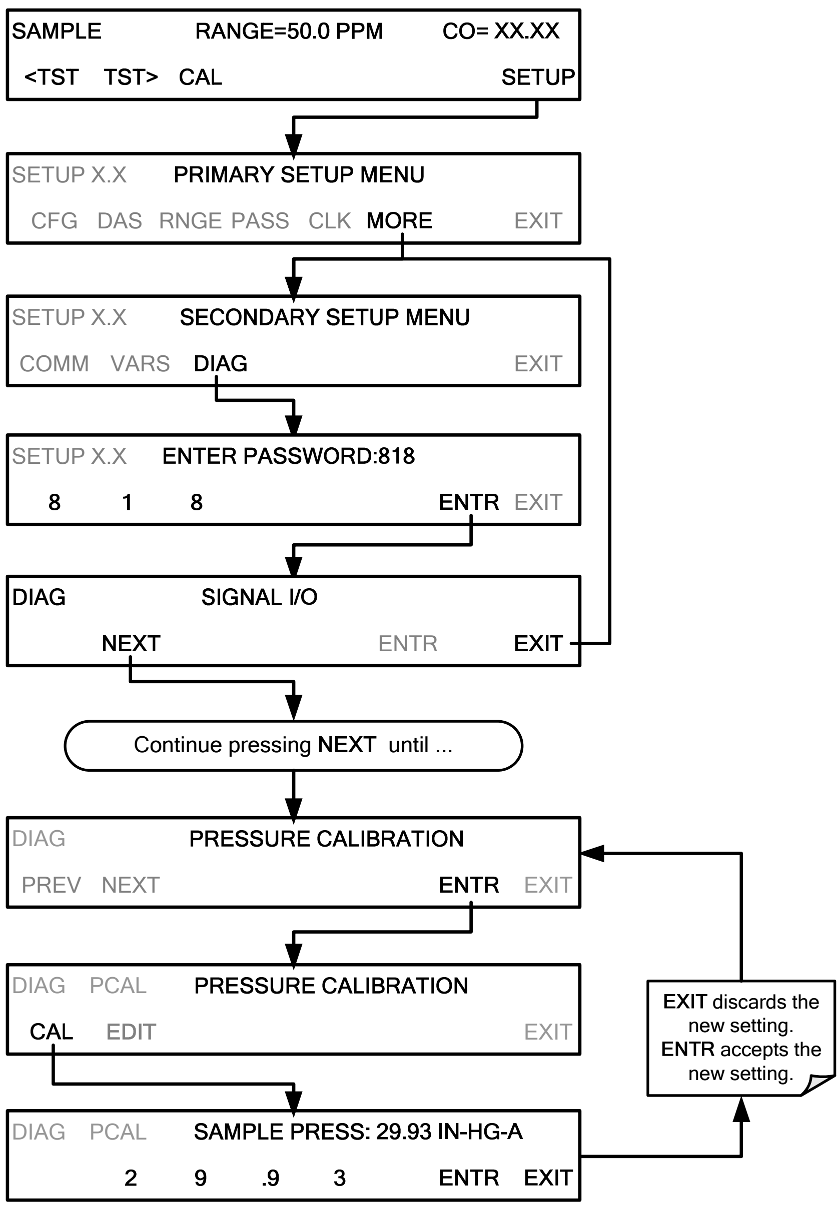


9.6.2. **PRESSURE CALIBRATION**

A sensor at the exit of the sample chamber continuously measures the pressure of the sample gas. This data is used to compensate the final CO concentration calculation for changes in atmospheric pressure and is stored in the CPU's memory as the test function **PRES** (also viewable via the front panel).

> **NOTE**
>
> **This calibration must be performed when the pressure of the sample gas is equal to ambient atmospheric pressure.**
>
> **Before performing the following pressure calibration procedure, disconnect the sample gas pump and the sample gas-line vent from the sample gas inlet on the instrument's rear panel.**

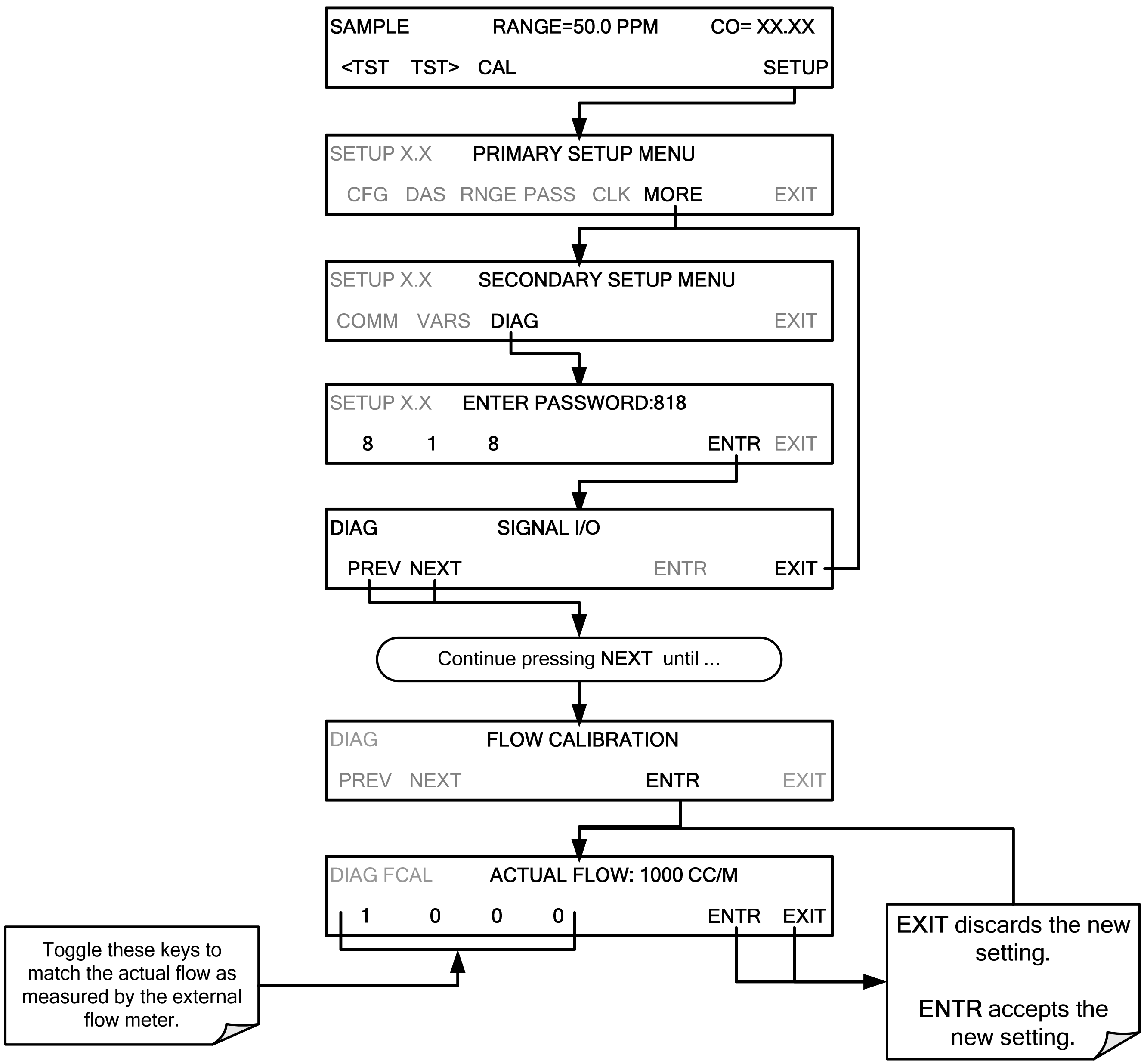
To cause the analyzer to measure and record a value for **PRES**, press.



9.6.3. **FLOW CALIBRATION**

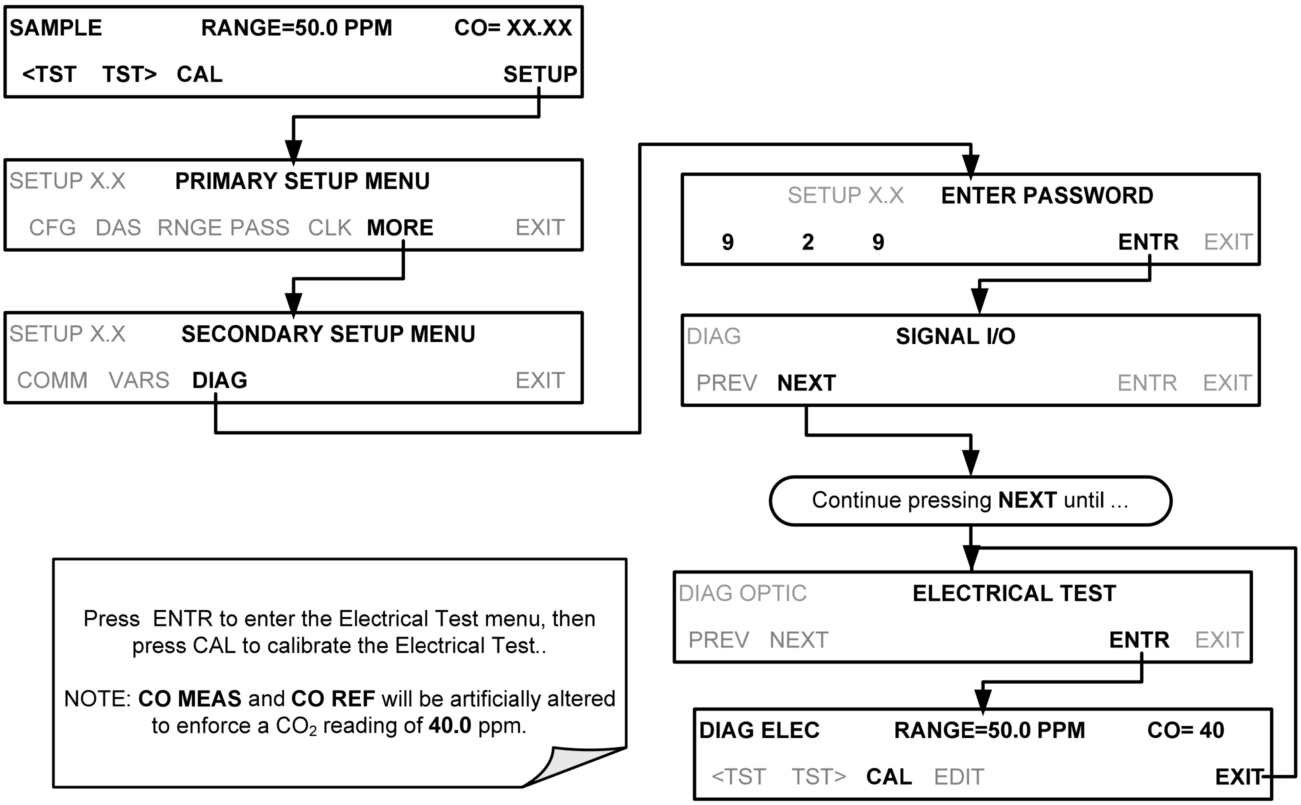
The flow calibration allows the user to adjust the values of the sample flow rates as they are displayed on the front panel and reported through COMM ports to match the actual flow rate measured at the sample inlet. This does not change the hardware measurement of the flow sensors, only the software-calculated values.

To carry out this adjustment, connect an external, sufficiently accurate flow meter to the sample inlet (see Section 12.3.4 for more details). Once the flow meter is attached and is measuring actual gas flow, press:



9.6.4. ELECTRICAL TEST CALIBRATION

To run the Electrical Test, see Section 13.5.6.2. For Electrical Test calibration the 929 password must be used:



9.7. CALIBRATION OF OPTIONAL SENSORS

9.7.1. O_2 SENSOR CALIBRATION PROCEDURE

9.7.1.1. O_2 Calibration Setup

The pneumatic connections for calibrating are as follows:

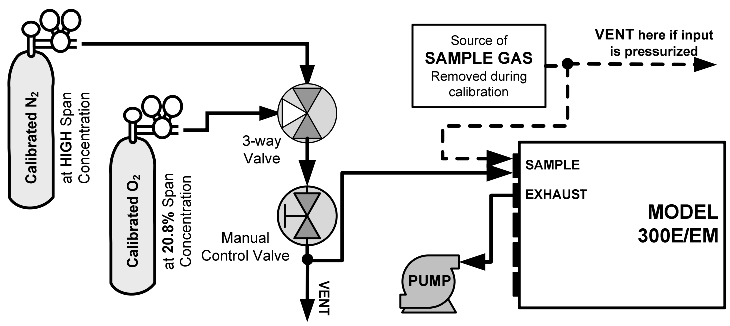


Figure 9-7: O_2 Sensor Calibration Set Up

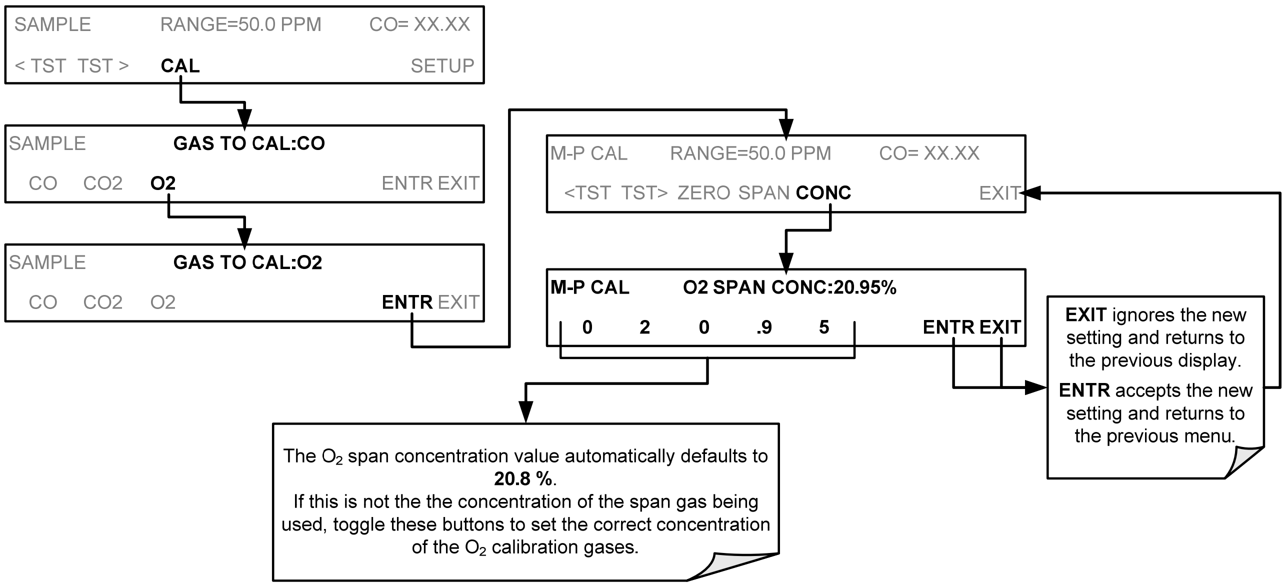
O_2 **SENSOR ZERO GAS:** Teledyne API recommends using pure N_2 when calibration the zero point of your O_2 sensor option.

O_2 **SENSOR SPAN GAS:** Teledyne API recommends using 20.8% O_2 in N_2 when calibration the span point of your O_2 sensor option (See Table 3-7).

9.7.1.2. **Set O_2 Span Gas Concentration**

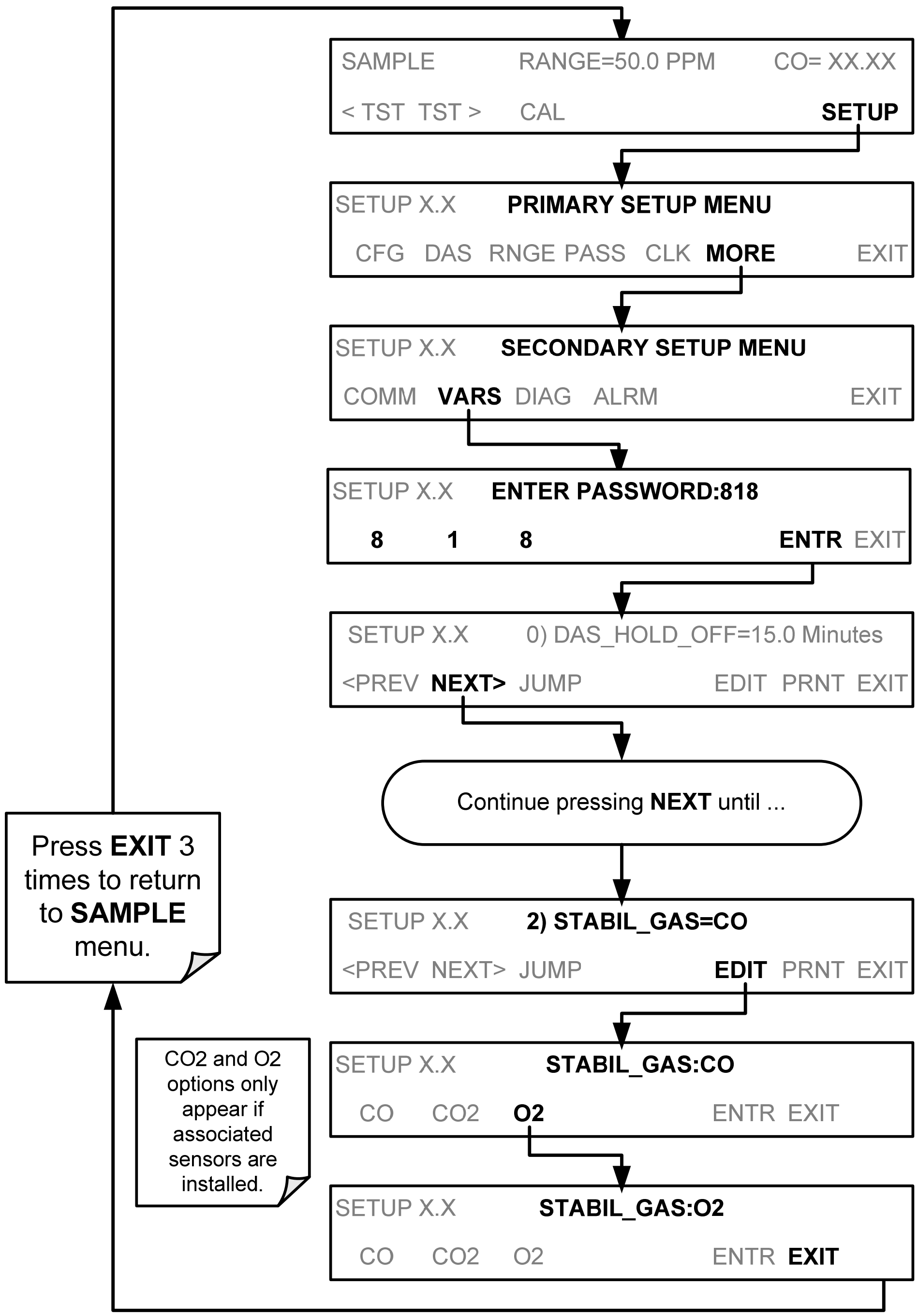
Set the expected O_2 span gas concentration.

This should be equal to the percent concentration of the O_2 span gas of the selected reporting range (default factory setting = 20.8%; the approximate O_2 content of ambient air).



9.7.1.3. **Activate O_2 Sensor Stability Function**

To change the stability test function from CO concentration to the O_2 sensor output, press:

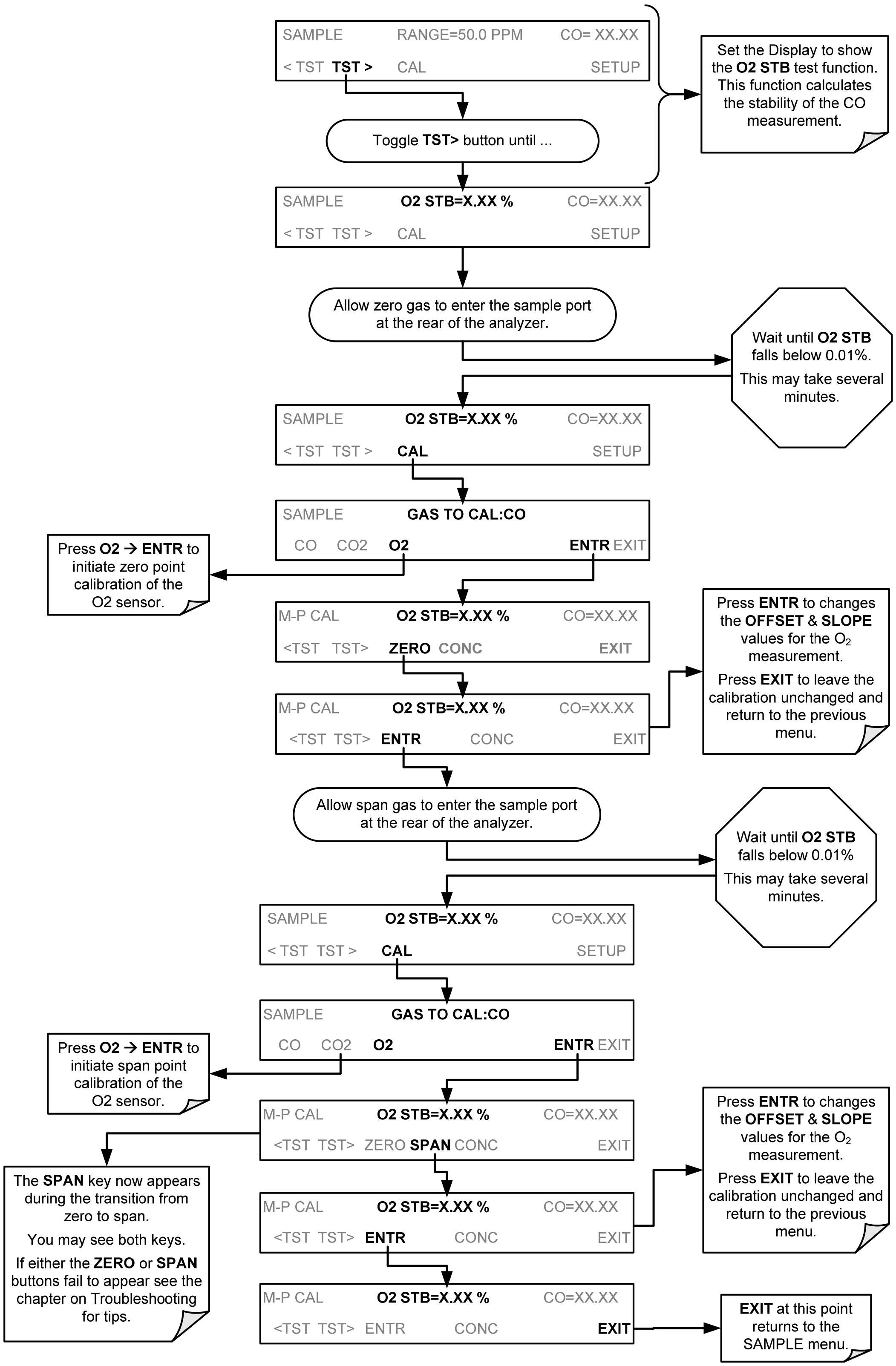


NOTE

Use the same procedure to reset the STB test function to CO when the O_2 calibration procedure is complete.

9.7.1.4. O_2ZERO/SPAN CALIBRATION

To perform the zero/span calibration procedure:



9.7.2. CO_2 SENSOR CALIBRATION PROCEDURE

9.7.2.1. CO_2 Calibration Setup

The pneumatic connections for calibrating are as follows

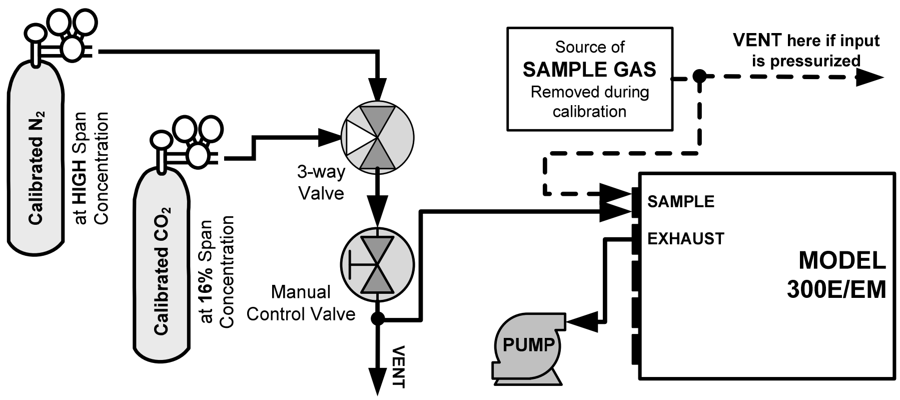


Figure 9-8: CO_2 Sensor Calibration Set Up

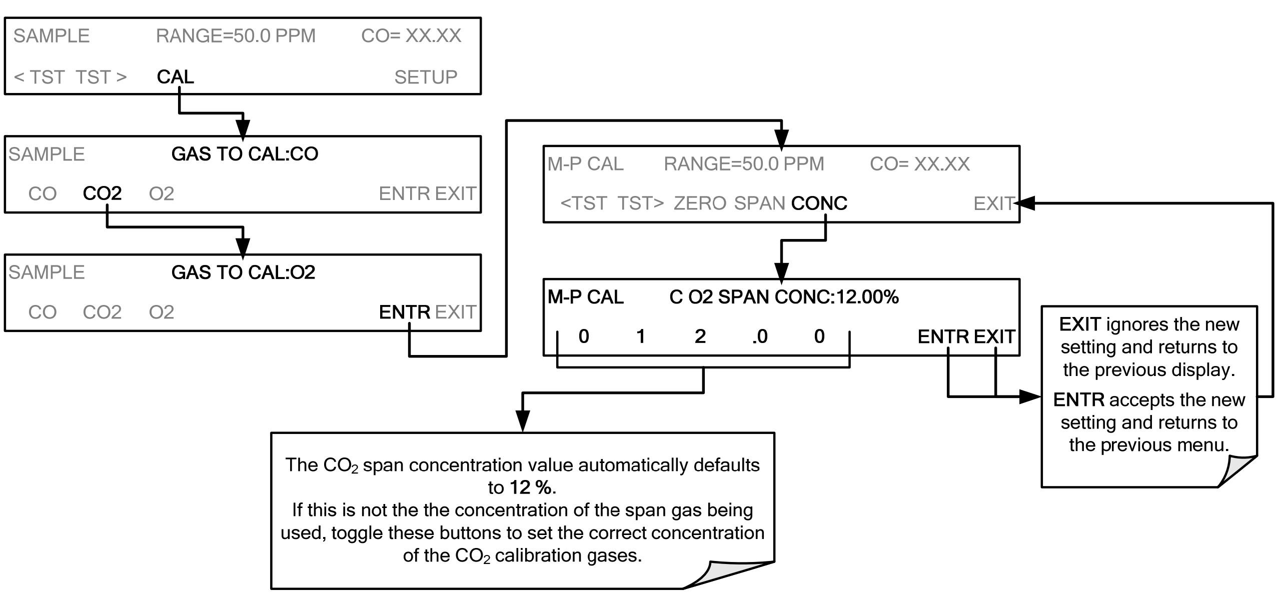
CO_2 **SENSOR ZERO GAS:** Teledyne API recommends using pure N_2 when calibration the zero point of your CO_2 sensor option.

CO_2 **SENSOR SPAN GAS:** Teledyne API recommends using 16% CO_2 in N_2 when calibration the span point of your CO_2 sensor option (Table 3-7) is 20%.

9.7.2.2. Set CO_2 Span Gas Concentration:

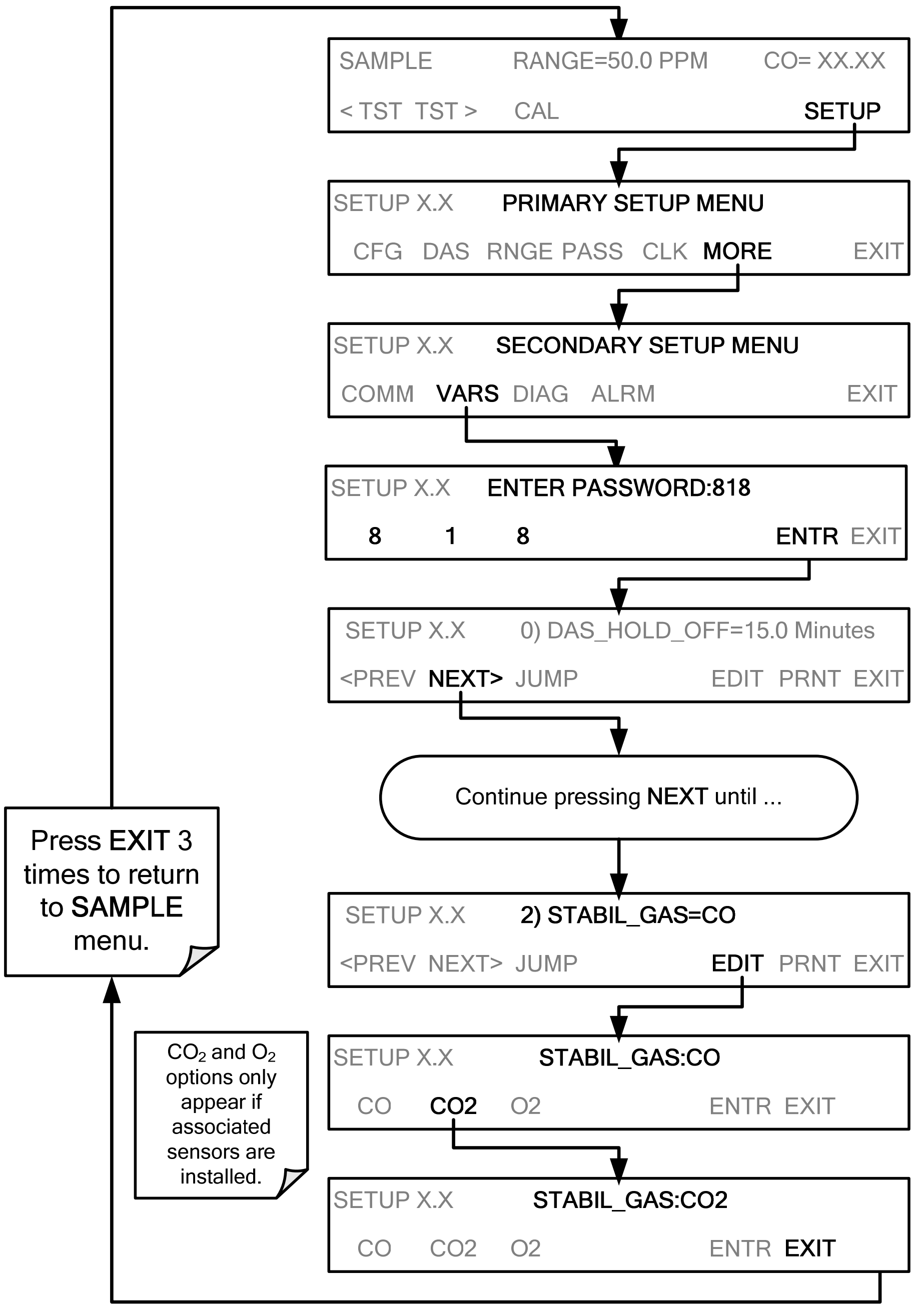
Set the expected CO_2 span gas concentration.

This should be equal to the percent concentration of the CO_2 span gas of the selected reporting range (default factory setting = 12%).



9.7.2.3. **Activate CO_2 Sensor Stability Function**

To change the stability test function from CO concentration to the CO_2 sensor output, press:

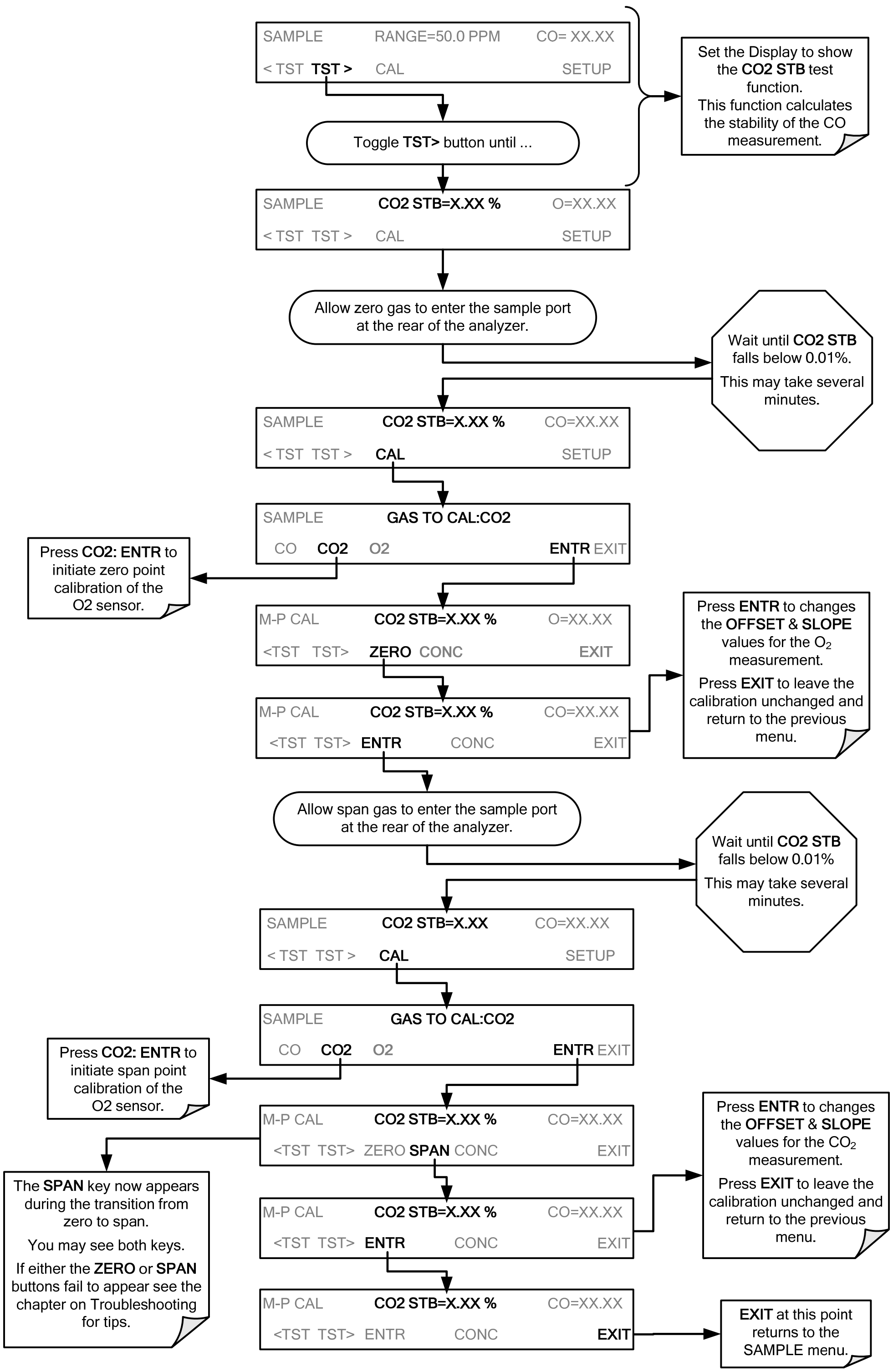


NOTE

Use the same procedure to reset the STB test function to CO when the CO_2 calibration procedure is complete.

9.7.2.4. CO_2 Zero/Span Calibration

To perform the zero/span calibration procedure:



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10. EPA CALIBRATION PROTOCOL

10.1. CALIBRATION REQUIREMENTS

If the M300E is to be used for EPA SLAMS monitoring, it must be calibrated in accordance with the instructions in this section.

The USEPA strongly recommends that you obtain a copy of the publication *Quality Assurance Handbook for Air Pollution Measurement Systems Volume 2: Part 1, Ambient* (abbreviated, *Q.A. Handbook Volume II*). This manual can be purchased from:

- USEPA Order Number: EPA454R98004; or NTIS Order Number: PB99 129876.
- National Technical Information Service (phone 800-553-6847) or Center for Environmental Research Information or the U.S. Government Printing Office at http://www.gpo.gov. The Handbook can also be located on line by searching for the title at http://www.epa.gov.
    - Special attention should be paid to Section 2.6 of that which covers CO analyzers of this type. Specific regulations regarding the use and operation of ambient CO analyzers can be found in Reference 1 at the end of this Section.

A bibliography and references relating to CO monitoring are listed in Section 10.6.

10.1.1. CALIBRATION OF EQUIPMENT - GENERAL GUIDELINES

In general, calibration is the process of adjusting the gain and offset of the M300E against some recognized standard. In this section the term *dynamic calibration* is used to express a multipoint check against known standards and involves introducing gas samples of known concentration into the instrument in order to adjust the instrument to a predetermined sensitivity and to produce a calibration relationship.

This relationship is derived from the instrumental response to successive samples of different known concentrations. As a minimum, three reference points and a zero point are recommended to define this relationship.

All monitoring instrument systems are subject to some drift and variation in internal parameters and cannot be expected to maintain accurate calibration over long periods of time. Therefore, it is necessary to dynamically check the calibration relationship on a predetermined schedule. *Zero and span checks* must be used to document that the data remains within control limits. These checks are also used in data reduction and validation.

Calibration can be done by either diluting high concentration CO standards with zero air or using individual tanks of known concentration. Details of documentation, forms and procedures should be maintained with each analyzer and also in a central backup file as described in Section 2.6.2 of the Quality Assurance Handbook.

The reliability and usefulness of all data derived from any analyzer depends primarily upon its state of calibration. To ensure accurate measurements of the CO levels:

1. The analyzer must be calibrated at the time of installation and recalibrated as necessary.
2. In order to insure that high quality, accurate measurement information is obtained at all times, the analyzer must be calibrated prior to use.
3. Calibrations should be carried out at the field-monitoring site.
4. The analyzer should be in operation for at least several hours (preferably overnight) before calibration so that it is fully warmed up and its operation has stabilized.

5. If the instrument will be used on more than one range, it should be calibrated separately on each applicable range.
6. Calibration documentation should be maintained with each analyzer and also in a central backup file.
7. The true values of the calibration gases used must be traceable to NIST-SRMs See Table 3-7.

10.1.2. CALIBRATION EQUIPMENT, SUPPLIES, AND EXPENDABLES

The measurement of CO in ambient air requires a certain amount of basic sampling equipment and supplemental supplies. The Quality Assurance Handbook Section 2.6 contains information about setting up the appropriate systems.

10.1.2.1. Data Recording Device

Either a strip chart recorder, data acquisition system, digital data acquisition system should be used to record the data from the Mode; M300E RS-232 port or analog outputs. If analog readings are being used, the response of that system should be checked against a NIST referenced voltage source or meter. Data recording device should be capable of bi-polar operation so that negative readings can be recorded.

10.1.2.2. Spare Parts and Expendable Supplies

In addition to the basic equipment described in the Q.A. Handbook, it is necessary to maintain an inventory of spare parts and expendable supplies. Section **Error! Reference source not found.** describes the parts that require periodic replacement and the frequency of replacement. Appendix B of this Technical Manual contains a list of spare parts and kits of expendables supplies.

Table 10-1: Matrix for Calibration Equipment & Supplies

EQUIPMENT & SUPPLIES	SPECIFICATION	REFERENCE	ACTION IF REQUIREMENTS ARE NOT MET
Recorder	Compatible with output signal of analyzer; min. chart width of 150 mm (6 in) is recommended		Return equipment to supplier
Sample line and manifold	Constructed of PTFE or glass	Check upon receipt	Return equipment to supplier
Calibration equipment	Q.A. Handbook[1] Vol II Part 1 , App 15, Sec. 4.4 & 5.4		Return equipment/ supplies to supplier or take corrective action
Detection limit	Noise = 0.5 ppm Lower detectable limit=1.0 ppm	40 CFR, Pt 53.20 & 23[2]	Instruments designated as reference or equivalent have been determined to meet these acceptance criteria.
Working standard CO cylinder gas	Traceable to NIST-SRM	Analyzed against NIST-SRM; 40 CFR, Pt 50, App C; para. 3.1[3]	Obtain new working standard and check for traceability
Zero air	Clean dry ambient air, free of contaminants that cause detectable response with the CO analyzer.	40 CFR, Pt 50, App C; para. 3.2[3]	Obtain air from another source or regenerate.
Record form	Q.A. Handbook[1] Vol II Part 1 , App 15, Table A-5 & A-6		Revise forms as appropriate
Audit equipment	Must not be the same as used for calibration	Q.A. Handbook[1] Vol II Part 1 , App 15, Sec. 4.4 & 5.4	Locate problem and correct or return to supplier

10.1.3. RECOMMENDED STANDARDS FOR ESTABLISHING TRACEABILITY

To assure data of desired quality, two considerations are essential:

- The measurement process must be in statistical control at the time of the measurement.
- The systematic errors, when combined with the random variation in the measurement process, must result in a suitably small uncertainty.

Evidence of good quality data includes documentation of the quality control checks and the independent audits of the measurement process by recording data on specific forms or on a quality control chart and by using materials, instruments, and measurement procedures that can be traced to appropriate standards of reference.

To establish traceability, data must be obtained routinely by repeat measurements of standard reference samples (primary, secondary and/or working standards). More specifically, working calibration standards must be traceable to standards of higher accuracy, such as those listed in Table 3-7.

Cylinders of working gas traceable to NIST-SRMs (called EPA Protocol Calibration Gas) are also commercially available (from sources such as Scott Specialty Gases, etc.). See Table 3-7 for a list of appropriate SRMs.

10.1.4. **CALIBRATION FREQUENCY**

To ensure accurate measurements of the CO concentrations, calibrate the analyzer at the time of installation, and recalibrate it:

- No later than three months after the most recent calibration or performance audit which indicate the analyzer's calibration to be acceptable.
- When there is an interruption of more than a few days in analyzer operation.
- When any repairs have taken place which might affect its calibration.
- After a physical relocation of the analyzer.
- When any other indication (including excessive zero or span drift) of possible significant inaccuracy of the analyzer exists.

Following any of the activities listed above, the zero and span should be checked to determine if a calibration is necessary.

Table 10-2: Activity Matrix for Quality Assurance Checks

Characteristic	Acceptance limits	Frequency and method of measurement	Action if requirements are not met
Shelter temperature	Mean temperature between 22°C and 28°C (72° and 82°F), daily fluctuations not greater than ±2°C	Check thermograph chart weekly for variations greater than ±2°C (4°F)	Mark strip chart for the affected time period Repair or adjust temperature control
Sample introduction system	No moisture, foreign material, leaks, obstructions; sample line connected to manifold	Weekly visual inspection	Clean, repair, or replace as needed
Recorder	Adequate ink & paper Legible ink traces Correct chart speed and range Correct time	Weekly visual inspection	Replenish ink and paper supply Adjust time to agree with clock; note on chart
Analyzer operational settings	**TEST** measurements at nominal values 2. M300E in Sample Mode	Weekly visual inspection	Adjust or repair as needed
Analyzer operational check	Zero and span within tolerance limits as described in Subsection 9.1.3 of Sec. 2.0.9 (Q.A. Handbook Vol II[4])	Level 1 zero/span every 2 weeks; Level 2 between Level 1 checks at frequency desired analyzer by user	Find source of error and repair After corrective action, re-calibrate analyzer
Precision check	Assess precision as described in Sec. 2.0.8 and Subsection 3.4.3 (Ibid.)	Every 2 weeks, Subsection 3.4.3 (Ibid.)	Calc, report precision, Sec. 2.0.8 (Ibid.)

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10.1.5. **LEVEL 1 CALIBRATIONS VERSUS LEVEL 2 CHECKS**

Essential to quality assurance are scheduled checks for verifying the operational status of the monitoring system. The operator should visit the site at least once each week. It is recommended Level 1 zero and span check conducted on the analyzer every two weeks. Level 2 zero and span checks should be conducted at a frequency desired by the user. Definitions of these terms are given in **Error! Reference source not found.**.

To provide for documentation and accountability of activities, a checklist should be compiled and then filled out by the field operator as each activity is completed.

Table 10-3: Definition of Level 1 and Level 2 Zero and Span Checks

(Q.A. Handbook[1] Vol II, Part1, Section 12.3 & 12.4)

LEVEL 1 ZERO AND SPAN CALIBRATION	**LEVEL 2 ZERO AND SPAN CHECK**
A Level 1 zero and span calibration is a simplified, two-point analyzer calibration used when analyzer linearity does not need to be checked or verified. (Sometimes when no adjustments are made to the analyzer, the Level 1 calibration may be called a zero/span check, in which case it must not be confused with a Level 2 zero/span check.) Since most analyzers have a reliably linear or near-linear output response with concentration, they can be adequately calibrated with only two concentration standards (two-point concentration). Furthermore, one of the standards may be zero concentration, which is relatively easily obtained and need not be certified. Hence, only one certified concentration standard is needed for the two-point (Level 1) zero and span calibration. Although lacking the advantages of the multipoint calibration, the two-point zero and span calibration--because of its simplicity--can be (and should be) carried out much more frequently. Also, two-point calibrations are easily automated. Frequency checks or updating of the calibration relationship with a two-point zero and span calibration improves the quality of the monitoring data by helping to keep the calibration relationship more closely matched to any changes (drifts) in the analyzer response.	A Level 2 zero and span check is an "unofficial" check of an analyzer's response. It may include dynamic checks made with uncertified test concentrations, artificial stimulation of the analyzer's detector, electronic or other types of checks of a portion of the analyzer, etc. Level 2 zero and span checks are not to be used as a basis for analyzer zero or span adjustments, calibration updates, or adjustment of ambient data. They are intended as quick, convenient checks to be used between zero and span calibrations to check for possible analyzer malfunction or calibration drift. Whenever a Level 2 zero or span check indicates a possible calibration problem, a Level 1 zero and span (or multipoint) calibration should be carried out before any corrective action is taken. If a Level 2 zero and span check is to be used in the quality control program, a "reference response" for the check should be obtained immediately following a zero and span (or multipoint) calibration while the analyzer's calibration is accurately known. Subsequent Level 2 check responses should then be compared to the most recent reference response to determine if a change in response has occurred. For automatic Level 2 zero and span checks, the first scheduled check following the calibration should be used for the reference response. It should be kept in mind that any Level 2 check that involves only part of the analyzer's system cannot provide information about the portions of the system not checked and therefore cannot be used as a verification of the overall analyzer calibration.

10.2. ZERO AND SPAN CHECKS

A system of Level 1 and Level 2 zero span checks is recommended. These checks must be conducted in accordance with the specific guidance given in Section 12 of the QA Handbook Vol II Part 1[1]. It is recommended that Level 1 zero and span checks be conducted every two weeks. Level 2 checks should be conducted in between the Level 1 checks at a frequency desired by the user. Span concentrations for both levels should be between 70 and 90% of the measurement range.

Zero and span data are to be used to:

1. Provide data to allow analyzer adjustment for zero and span drift;
2. Provide a decision point on when to calibrate the analyzer;
3. Provide a decision point on invalidation of monitoring data.

Items 1 and 2 are described in detail in Subsection 9.1.3 of Section 2.0.9 (Q.A. Handbook Vol II[4]). Item 3 is described in Subsection 9.1.4 of the same section.

Refer to the Troubleshooting and Repair (see Section 13) of this manual if the instrument is not within the allowed variations.

10.2.1. ZERO/SPAN CHECK PROCEDURES

The Zero and Span calibration can be checked in a variety of different ways. They include:

- Manual Zero/Span Check - Zero and Span can be checked from the front panel keyboard. The procedure is in Section 9.3 of this manual.
- Automatic Zero/Span Checks - After the appropriate setup, Z/S checks can be performed automatically every night. See Section 9.3 of this manual for setup and operation procedures.

  If using the AutoCal feature to perform a calibration check, set the **CALIBRATE** parameter to **NO**.
- Zero/Span checks via remote contact closure = Zero/Span checks can be initiated via remote contact closures on the rear panel. See Section 9.3.3.3 of this manual.
- Zero/Span via RS-232 port - Z/S checks can be controlled via the RS-232 port. See Section 9.3.3.3 and Appendix A-6 of this manual for more details.

10.2.2. PRECISION CHECK

A periodic check is used to assess the data for precision. A one-point precision check must be carried out at least once every 2 weeks on each analyzer at a CO concentration between 8.0 ppm and 10.0 ppm.

The analyzer must be operated in its normal sampling mode, and the precision test gas must pass through all filters, scrubbers, conditioners, and other components used during normal ambient sampling.

The standards from which precision check test concentrations are obtained must be traceable to NIST-SRM. Those standards used for calibration or auditing may be used.

To perform a precision check during the instrument set up, the sources of zero air and sample gas and procedures should conform to those described in Section **Error! Reference source not found.** for analyzers with no valve options or with an IZS valve option installed and Section 9.3.1 for analyzers with Z/S options installed with the following exception:

- Connect the analyzer to a precision gas that has a CO concentration between 8.0 ppm and 10.0 ppm. If a precision check is made in conjunction with a zero/span check, it must be made prior to any zero or span adjustments.
- Record this value.

Information from the check procedure is used to assess the precision of the monitoring data; see CFR 40 CFR 58[5] for procedures for calculating and reporting precision.

10.3. PRECISIONS CALIBRATION

Calibration must be performed with a calibrator that meets all conditions specified in QA Handbook[1] Vol II Part 1, App 15, Sec. 4.4 & 5.4. The user should be sure that all flow meters are calibrated under the conditions of use against a reliable standard. All volumetric flow rates should be corrected to 25°C (77°F) and 760 mm-Hg (29.92in–Hg). Make sure the calibration system can supply the range of the concentration at a sufficient flow over the whole range of concentration that will be encountered during calibration.

All operational adjustments to the M300E should be completed prior to the calibration. The following software features must be set into the desired state before calibration.

- If the instrument will be used for more than one range, it should be calibrated separately on each applicable range.
- Automatic temperature/pressure compensation should be enabled. See Section 6.6.

- Alternate units, make sure ppm units are selected for EPA monitoring. See Section 6.6.4.

The analyzer should be calibrated on the same range used for monitoring.

10.3.1. **PRECISION CALIBRATION PROCEDURES**

To perform a precision calibration during the instrument set up, the input sources of zero air and sample gas and procedures should conform to those described in Section **Error! Reference source not found.** for analyzers with no valve options or with an IZS valve option installed and Section 9.3 for analyzers with Z/S options installed.

10.4. **AUDITING PROCEDURE**

An audit is an independent assessment of the accuracy of data. Independence is achieved by having the audit made by an operator other than the one conducting the routine field measurements and by using audit standards and equipment different from those routinely used in monitoring. The audit should be a true assessment of the measurement process under normal operations without any special preparation or adjustment of the system. Routine quality control checks conducted by the operator are necessary for obtaining and reporting good quality data, but they are not considered part of the auditing procedure. Audits are recommended once per quarter, but frequency may be determined by applicable regulations and end use of the data.

Refer to The Q.A. Handbook[1] Volume II, Part 1 Section 16 (for a more detailed description).

10.4.1. **CALIBRATION AUDIT**

A calibration audit consists of challenging the M300E/EM with known concentrations of CO. The difference between the known concentration and the analyzer response is obtained, and an estimate of the analyzer's accuracy is determined.

The recommended audit schedule depends on the purpose for which the monitoring data are being collected. For example, Appendix A, 40 CFR 58[5] requires that each analyzer in State and Local Air Monitoring Network Plan (SLAMS) be audited at least once a year. Each agency must audit 25% of the reference or equivalent analyzers each quarter. If an agency operates less than four reference or equivalent analyzers, it must randomly select analyzers for reauditing so that one analyzer will be audited each calendar quarter and each analyzer will be audited at least once a year.

Appendix B, 40 CFR 58[5] requires that each Prevention of Significant Deterioration (PSD) reference or equivalent analyzer be audited at least once a sampling quarter. Results of these audits are used to estimate the accuracy of ambient air data.

10.4.2. **DATA REDUCTION AUDIT**

A data reduction audit involves transcribing analyzer data and determining if the collected data is within the control limits, generally ±2 ppm between the analyzer response and the audit value. The resulting values are recorded on the SAROAD form. If data exceeds ±2 ppm, check <u>all</u> of the remaining data in the 2-week period.

10.4.3. SYSTEM AUDIT/VALIDATION

A system audit is an on-site inspection and review of the quality assurance activities used for the total measurement system (sample collection, sample analysis, data processing, etc.); it is an appraisal of system quality.

Conduct a system audit at the startup of a new monitoring system and periodically (as appropriate) as significant changes in system operations occur.

10.5. DYNAMIC MULTIPOINT CALIBRATION PROCEDURE

10.5.1. LINEARITY TEST

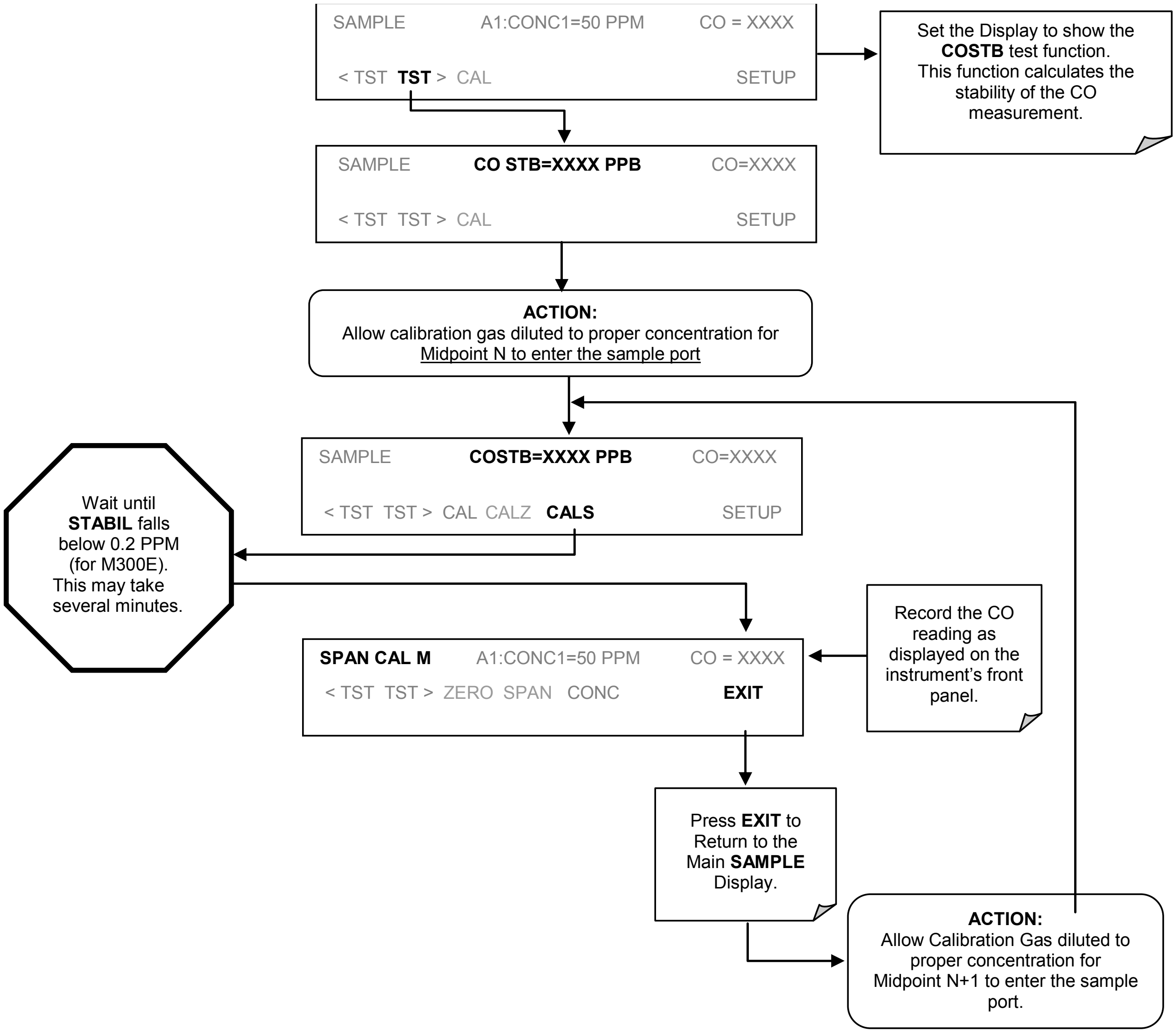
In order to record the instrument's performance at a predetermined sensitivity and to derive a calibration relationship, a minimum of three reference points and one zero point uniformly spaced covering 0 to 90 percent of the operating range are recommended to define this relationship.

The analyzer's recorded response is compared with the known concentration to derive the calibration relationship.

To perform a precision check during the instrument set up, the sources of zero air and sample gas should conform to those described in Section 9.1.2.

Follow the procedures described in Section 9.3 for calibrating the zero points.

For each mid point:



Plot the analyzer responses versus the corresponding calculated concentrations to obtain a calibration relationship. Determine the best-fit straight line (y = mx + b) determined by the method of least squares.

After the best-fit line has been drawn, determine whether the analyzer response is linear. To be considered linear, no calibration point should differ from the best-fit line by more than ±2% of full scale.

If carried out carefully, the checks described in this section will provide reasonable confidence that the M300E is operating properly. Checks should be carried out at least every 3 months as the possibility of malfunction is always present.

If the linearity error is excessive and cannot be attributed to outside causes, check the M300E system for:

- Sample pressure higher than ambient – pressurized sample gas
- Leaks
- Correct flow
- Miscalibrated span gas tanks or bad zero gas
- Miscalibrated sample pressure transducer
- Failed IR detector, GFC Wheel or Sync/Demod Board
- Contaminated optical bench or sample lines

10.6. REFERENCES

[1] Quality Assurance Handbook for Air Pollution Measurement Systems Volume II: Part 1 - Ambient Air Quality Monitoring Program Quality System Development - EPA-454/R-98-004 - August 1998. United States Environmental Protection Agency - Office of Air Quality Planning and Standards

[2] CFR Title 40: Protection of Environment - PART 53—AMBIENT AIR MONITORING REFERENCE AND EQUIVALENT METHODS:
- 53.20 General provisions.
- 53.23 Test procedures.

[3] CFR Title 40: Protection of Environment - PART 50—NATIONAL PRIMARY AND SECONDARY AMBIENT AIR QUALITY STANDARDS: Appendix C to Part 50—Measurement Principle and Calibration Procedure for the Measurement of Carbon Monoxide in the Atmosphere (Non-Dispersive Infrared Photometry)

[4] Quality Assurance Handbook for Air Pollution Measurement Systems - Volume II, Ambient Air Specific Methods, EPA-600/4-77-027a, 1977.

[5] CFR Title 40: Protection of Environment - AMBIENT AIR QUALITY SURVEILLANCE

PART III
–
TECHNICAL INFORMATION

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11. THEORY OF OPERATION

The M300E/EM Gas Filter Correlation Carbon monoxide Analyzer is a microprocessor-controlled analyzer that determines the concentration of carbon monoxide (CO) in a sample gas drawn through the instrument. It requires that the sample and calibration gases be supplied at ambient atmospheric pressure in order to establish a stable gas flow through the sample chamber where the gases ability to absorb infrared radiation is measured.

Calibration of the instrument is performed in software and does not require physical adjustments to the instrument. During calibration, the microprocessor measures the current state of the IR Sensor output and various other physical parameters of the instrument and stores them in memory.

The microprocessor uses these calibration values, the IR absorption measurements made on the sample gas along with data regarding the current temperature and pressure of the gas to calculate a final CO concentration.

This concentration value and the original information from which it was calculated are stored in one of the unit's internal data acquisition system (iDAS - See Sections 7.1) as well as reported to the user via a vacuum florescent display or a variety of digital and analog signal outputs.

11.1. MEASUREMENT METHOD

11.1.1. BEER'S LAW

The basic principle by which the analyzer works is called the Beer-Lambert Law or Beer's Law. It defines how light of a specific wavelength is absorbed by a particular gas molecule over a certain distance. The mathematical relationship between these three parameters is:

$$I = I_o \, e^{-\alpha L c}$$

Equation 11-1

Where:

I_o is the intensity of the light if there was no absorption.

I is the intensity with absorption.

L is the absorption path, or the distance the light travels as it is being absorbed.

C is the concentration of the absorbing gas; in the case of the M300E/EM, Carbon Monoxide (CO).

α is the absorption coefficient that tells how well CO absorbs light at the specific wavelength of interest.

11.2. MEASUREMENT FUNDAMENTALS

In the most basic terms, the M300E/EM uses a high-energy heated element to generate a beam of broad-band IR light with a known intensity (measured during instrument calibration). This beam is directed through multi-pass cell filled with sample gas. The sample cell uses mirrors at each end to reflect the IR beam back and forth through the sample gas a number of times (see Figure 11-1).

The total length that the reflected light travels is directly related to the intended sensitivity of the instrument. The lower the concentrations the instrument is designed to detect, the longer the light path must be in order to create detectable levels of attenuation.

Lengthening the absorption path is accomplished partly by making the physical dimension of the reaction cell longer, but primarily by adding extra passes back and forth along the length of the chamber.

Table 11-1: Absorption Path Lengths for M300E and M300EM

MODEL	TOTAL NUMBER OF REFLECTIVE PASSES	DISTANCE BETWEEN MIRRORS	TOTAL ABSORPTION LIGHT PATH
M300E	32	437.5 mm	14 Meters
M300EM	8	312.5 mm	2.5 Meters

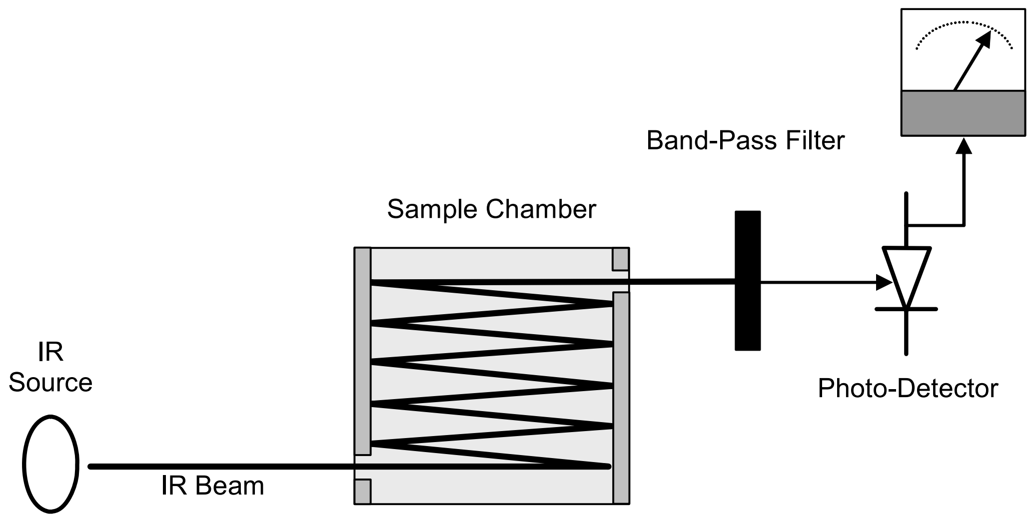


Figure 11-1: Measurement Fundamentals

Upon exiting the sample cell, the beam shines through a band-pass filter that allows only light at a wavelength of 4.7 µm to pass. Finally, the beam strikes a solid-state photo-detector that converts the light signal into a modulated voltage signal representing the attenuated intensity of the beam.

11.2.1. GAS FILTER CORRELATION

Unfortunately, water vapor absorbs light at 4.7 µm too. To overcome the interfering effects of water vapor the M300E/EM adds another component to the IR light path called a Gas Filter Correlation (GFC) Wheel.

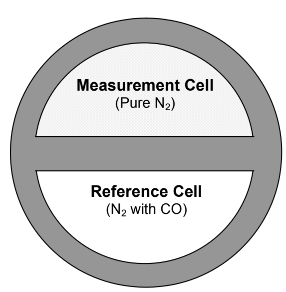


Figure 11-2: GFC Wheel

11.2.1.1. **The GFC Wheel**

A GFC Wheel is a metallic wheel into which two chambers are carved. The chambers are sealed on both sides with material transparent to 4.7 µm IR radiation creating two airtight cavities. Each cavity is mainly filled with composed gases. One cell is filled with pure N_2 (the measurement cell). The other is filled with a combination of N_2 and a high concentration of CO (the reference cell).

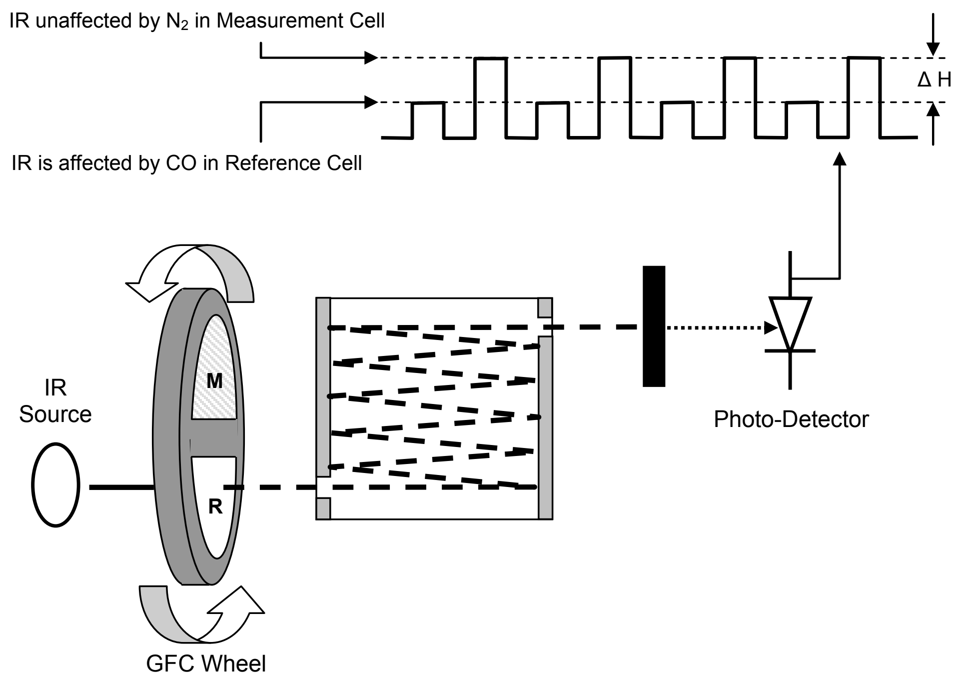


Figure 11-3: Measurement Fundamentals with GFC Wheel

As the GFC Wheel spins, the IR light alternately passes through the two cavities. When the beam is exposed to the reference cell, the CO in the gas filter wheel strips the beam of most of the IR at 4.7µm. When the light beam is exposed to the measurement cell, the N_2 in the filter wheel does not absorb IR light. This causes a fluctuation in the intensity of the IR light striking the photo-detector which results in the output of the detector resembling a square wave.

11.2.1.2. The Measure Reference Ratio

The M300E/EM determines the amount of CO in the sample chamber by computing the ratio between the peak of the measurement pulse (**CO MEAS**) and the peak of the reference pulse (**CO REF**).

If no gases exist in the sample chamber that absorb light at 4.7µm, the high concentration of CO in the gas mixture of the reference cell will attenuate the intensity of the IR beam by 60% giving a M/R ratio of approximately 2.4:1.

Adding CO to the sample chamber causes the peaks corresponding to both cells to be attenuated by a further percentage. Since the intensity of the light passing through the measurement cell is greater, the effect of this additional attenuation is greater. This causes **CO MEAS** to be more sensitive to the presence of CO in the sample chamber than **CO REF** and the ratio between them (M/R) to move closer to 1:1 as the concentration of CO in the sample chamber increases.

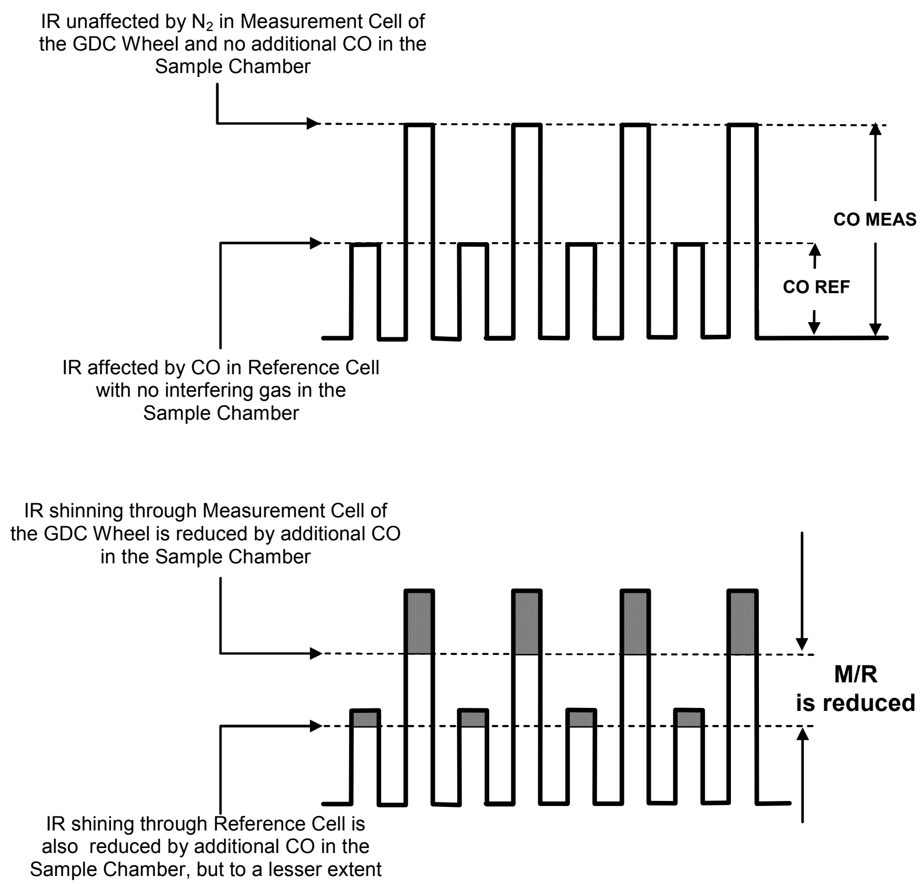


Figure 11-4: Effect of CO in the Sample on CO MEAS & CO REF

Once the M300E/EM has computed this ratio, a look-up table is used, with interpolation, to linearize the response of the instrument. This linearized concentration value is combined with calibration SLOPE and OFFSET values to produce the CO concentration which is then normalized for changes in sample pressure.

Interference and Signal to Noise Rejection:

If an interfering gas, such as H_2O vapor is introduced into the sample chamber, the spectrum of the IR beam is changed in a way that is identical for both the reference and the measurement cells, but without changing the ratio between the peak heights of **CO MEAS** and **CO REF**. In effect, the difference between the peak heights remains the same.

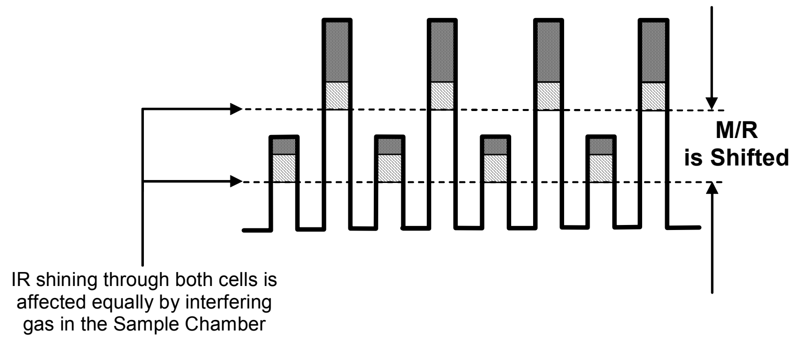


Figure 11-5: Effects of Interfering Gas on CO MEAS & CO REF

Thus, the difference in the peak heights and the resulting M/R ratio is only due to CO and not to interfering gases. In this case, GFC rejects the effects of interfering gases and so that the analyzer responds only to the presence of CO.

To improve the signal-to-noise performance of the IR photo-detector, the GFC Wheel also incorporates an optical mask that chops the IR beam into alternating pulses of light and dark at six times the frequency of the measure/reference signal. This limits the detection bandwidth helping to reject interfering signals from outside this bandwidth improving the signal to noise ratio.

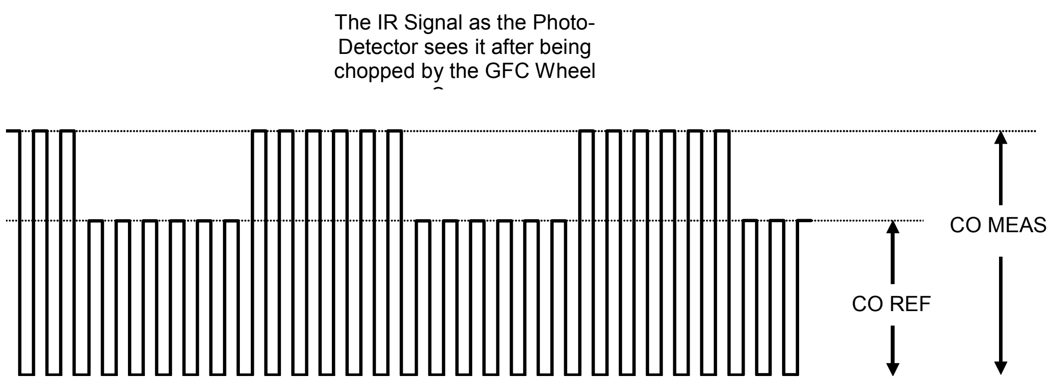


Figure 11-6: Chopped IR Signal

11.2.1.3. **Summary Interference Rejection**

The basic design of the M300E/EM rejects most of this interference at a 300:1 ratio. The two primary methods used to accomplish this are:

- The 4.7µm band pass filter just before the IR sensor which allows the instrument to only react to IR absorption in the wavelength affected by CO.
- Comparison of the measure and reference signals and extraction of the ratio between them.

11.3. **PNEUMATIC OPERATION**

	CAUTION **GENERAL SAFETY HAZARD** **It is important that the sample airflow system is both leak tight and not pressurized over ambient pressure.** **Regular leak checks should be performed on the analyzer as described in the maintenance schedule, Table 12-1.** **Procedures for correctly performing leak checks can be found in Section 12.3.3.**

An internal pump evacuates the sample chamber creating a small vacuum that draws sample gas into the analyzer. Normally the analyzer is operated with its inlet near ambient pressure either because the sample is directly drawn at the inlet or a small vent is installed at the inlet. There are several advantages to this “pull through” configuration.

- By placing the pump down stream from the sample chamber several problems are avoided.
- First the pumping process heats and compresses the sample air complicating the measurement process.
- Additionally, certain physical parts of the pump itself are made of materials that might chemically react with the sample gas.
- Finally, in certain applications where the concentration of the target gas might be high enough to be hazardous, maintaining a negative gas pressure relative to ambient means that should a minor leak occur, no sample gas will be pumped into the atmosphere surrounding analyzer.

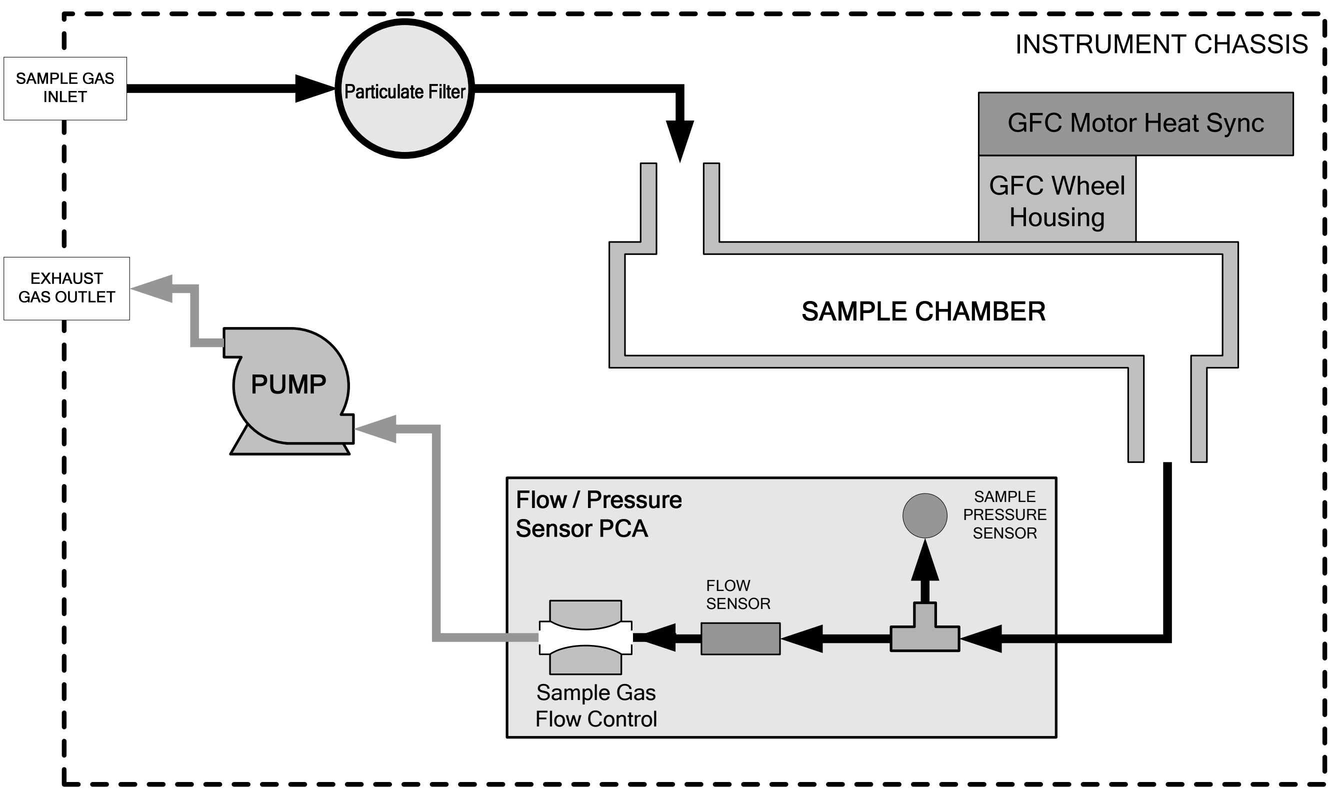


Figure 11-7: Internal Pneumatic Flow – Basic Configuration

11.4. FLOW RATE CONTROL

To maintain a constant flow rate of the sample gas through the instrument, the M300E/EM uses a special flow control assembly located in the exhaust gas line just before the pump. In instruments with the O_2 sensor installed, a second flow control assembly is located between the O_2 sensor assembly and the pump. These assemblies consist of:

- A critical flow orifice.
- Two o-rings: Located just before and after the critical flow orifice, the o-rings seal the gap between the walls of assembly housing and the critical flow orifice.
- A spring: Applies mechanical force needed to form the seal between the o-rings, the critical flow orifice and the assembly housing.

11.4.1.1. Critical Flow Orifice

The most important component of this flow control assembly is the critical flow orifice.

Critical flow orifices are a remarkably simple way to regulate stable gas flow rates. They operate without moving parts by taking advantage of the laws of fluid dynamics. By restricting the flow of gas though the orifice, a pressure differential is created. This pressure differential combined with the action of the analyzer's pump draws the gas through the orifice.

As the pressure on the downstream side of the orifice (the pump side) continues to drop, the speed that the gas flows through the orifice continues to rise. Once the ratio of upstream pressure to downstream pressure is greater than 2:1, the velocity of the gas through the orifice reaches the speed of sound. As long as that ratio stays at least 2:1, the gas flow rate is unaffected by any fluctuations, surges, or changes in downstream pressure because such variations only travel at the speed of sound themselves and are therefore cancelled out by the sonic shockwave at the downstream exit of the critical flow orifice.

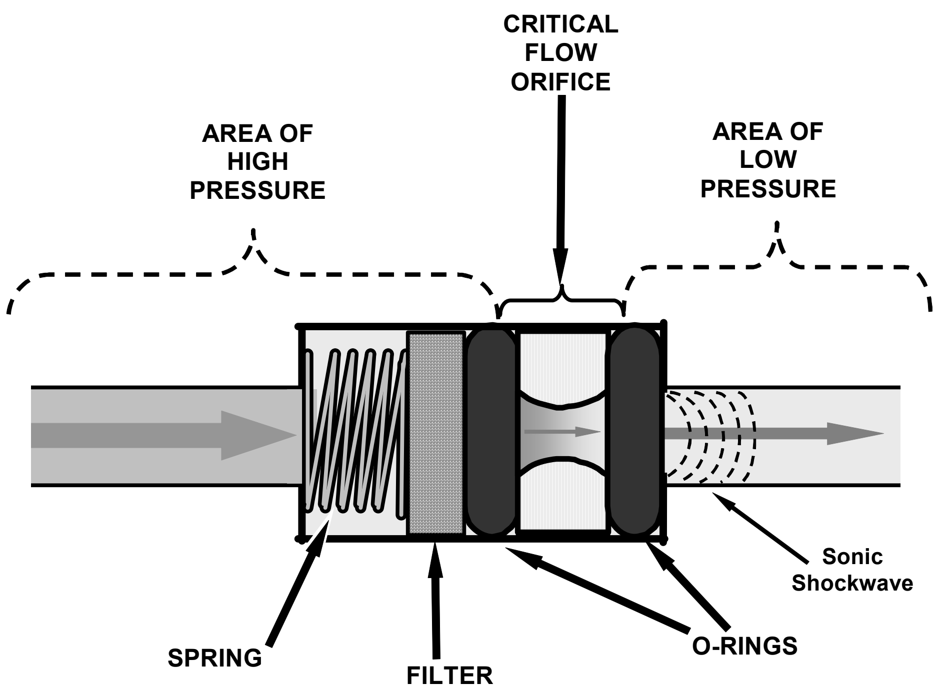


Figure 11-8: Flow Control Assembly & Critical Flow Orifice

The actual flow rate of gas through the orifice (volume of gas per unit of time), depends on the size and shape of the aperture in the orifice. The larger the hole, the more the gas molecules move at the speed of sound and pass through the orifice. Because the flow rate of gas through the orifice is only related to the minimum 2:1 pressure differential and not absolute pressure, the flow rate of the gas is also unaffected by degradations in pump efficiency due to age.

The critical flow orifice used in the M300E/EM is designed to provide a flow rate of 800 cc/min.

11.4.2. PARTICULATE FILTER

The M300E/EM Analyzer comes equipped with a 47 mm diameter, Teflon, particulate filter with a 5 micron pore size. The filter is accessible through the front panel, which folds down to allow access, and should be changed according to the suggested maintenance schedule described in Table 12-1.

11.4.3. PNEUMATIC SENSORS

11.4.3.1. Sample Pressure Sensor

An absolute value pressure transducer plumbed to the outlet of the sample chamber is used to measure sample pressure. The output of the sensor is used to compensate the concentration measurement for changes in air pressure. This sensor is mounted to a printed circuit board with the Sample Flow Sensor on the sample chamber (see Section 11.4.3.2 and Figure 3-4

11.4.3.2. Sample Flow Sensor

A thermal-mass flow sensor is used to measure the sample flow through the analyzer. The sensor is calibrated at the factory with ambient air or N_2, but can be calibrated to operate with samples consisting of other gases such as CO. This sensor is mounted to a printed circuit board with the Sample Pressure Sensor on the sample chamber (see Section 11.4.3.1 and Figure 3-4).).

11.5. ELECTRONIC OPERATION

11.5.1. OVERVIEW

Figure 11-9 shows a block diagram of the major electronic components of the M300E/EM.

At the heart of the analyzer is a microcomputer/CPU that controls various internal processes, interprets data, makes calculations, and reports results using specialized firmware developed by Teledyne API. It communicates with the user as well as receives data from and issues commands to a variety of peripheral devices via a separate printed circuit assembly called the motherboard.

The motherboard collects data, performs signal conditioning duties and routes incoming and outgoing signals between the CPU and the analyzer's other major components.

Data is generated by a gas-filter-correlation optical bench which outputs an analog signal corresponding to the concentration of CO in the sample gas. This analog signal is transformed into two, pre-amplified, DC voltages (**CO MEAS** and **CO REF**) by a synchronous demodulator printed circuit assembly. **CO MEAS** and **CO REF** are converted into digital data by a unipolar, analog-to-digital converter, located on the motherboard.

A variety of sensors report the physical and operational status of the analyzer's major components, again through the signal processing capabilities of the motherboard. These status reports are used as data for the CO concentration calculation and as trigger events for certain control commands issued by the CPU. They are stored in memory by the CPU and in most cases can be viewed but the user via the front panel display.

The CPU communicates with the user and the outside world in a variety of manners:

- Through the analyzer's keyboard and vacuum florescent display over a clocked, digital, serial I/O bus (using a protocol called I^2C);
- RS-232 & RS-485 Serial I/O channels;
- Via an optional Ethernet communications card:
- Various analog and current analog outputs, and
- Several sets of Digital I/O channels.

Finally, the CPU issues commands via a series of relays and switches (also over the I^2C bus) located on a separate printed circuit assembly to control the function of key electromechanical devices such as heaters, motors and valves.

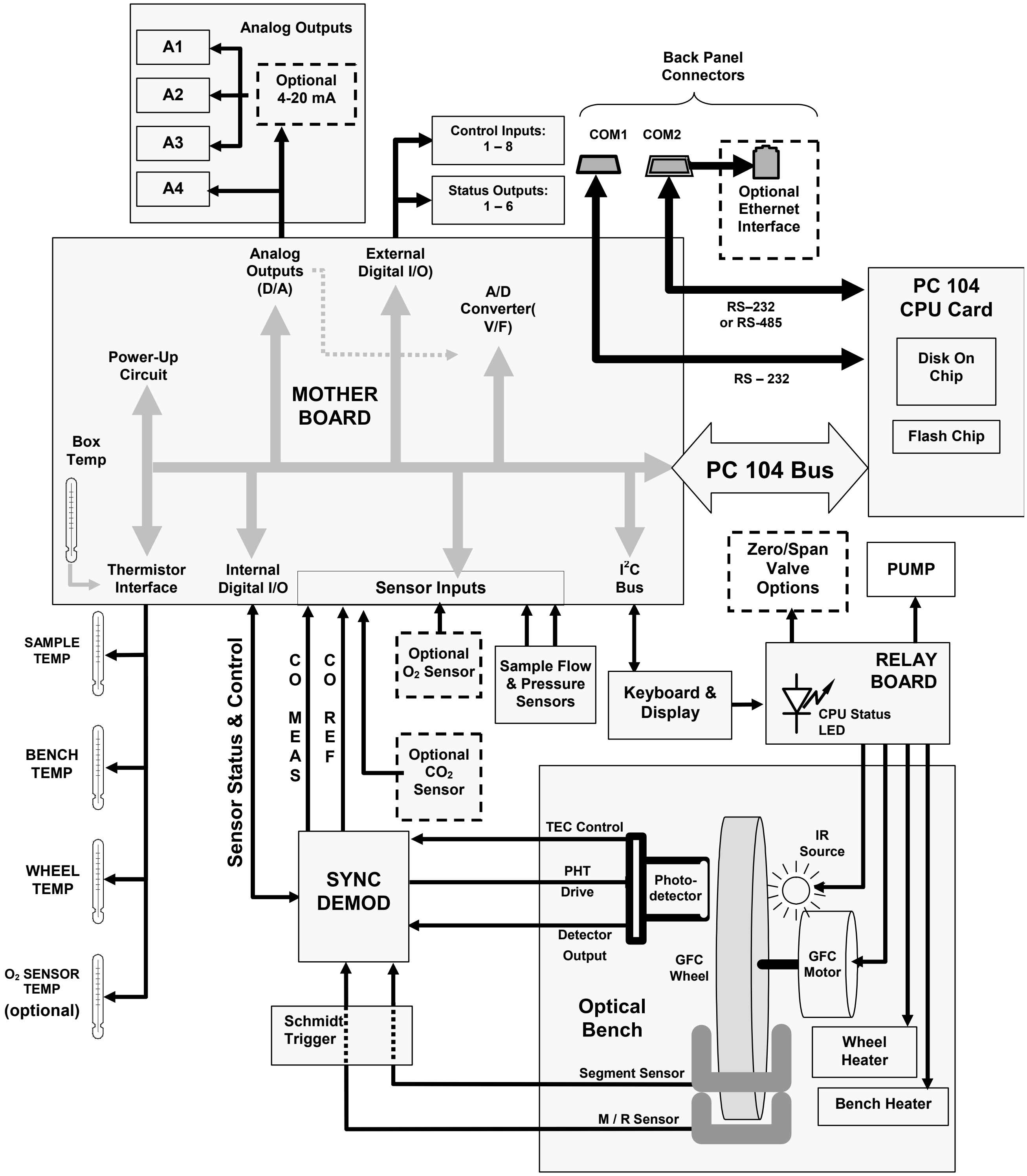
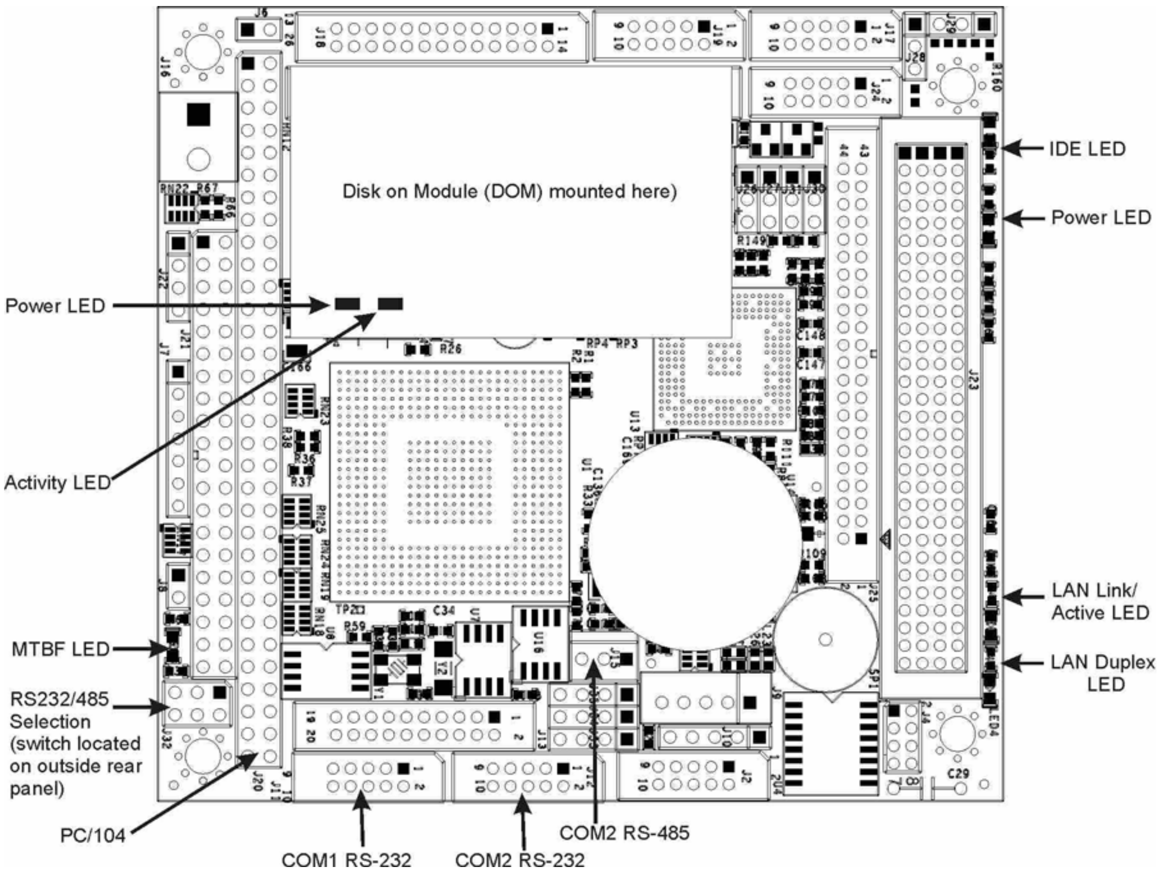


Figure 11-9: M300E/EM Electronic Block Diagram

11.5.2. **CENTRAL PROCESSING UNIT (CPU)**

The CPU for the E-Series instruments is a low power (5 VDC, 360mA MAX), high performance, Vortex86SX-based microcomputer running MS-DOS; its operation and assembly are compliant with the PC/104 Standard. The CPU is installed on the motherboard located inside the rear panel. It supports both RS-232 and RS-485 serial I/O.



The CPU includes two types of non-volatile data storage: a Disk-on-Module and an embedded flash chip.

DISK-ON-MODULE (DOM)

While technically an EEPROM, the DOM,is a 44-pin IDE flash drive with a storage capacity up to 128 MB. It is used to store the operating system for the computer, the Teledyne API's Firmware, and most of the operational data generated by the analyzer's internal data acquisition system (iDAS - See Section 7.1).

FLASH CHIP

Another, smaller EEPROM is the flash chip embedded in the CPU, which is used to store critical calibration and configuration data. Storing these key data on a separate, less heavily accessed chip significantly decreases the chance of the data being corrupted.

In the unlikely event that the flash chip should fail, the analyzer will continue to operate with just the DOM. However, all configuration information will be lost, requiring the unit to be recalibrated.

11.5.3. **OPTICAL BENCH & GFC WHEEL**

Electronically, in the case of the optical bench for the M300E Analyzer, GFC Wheel and associated components do more than simply measure the amount of CO present in the sample chamber. A variety of other critical functions are performed here as well.

11.5.3.1. **Temperature Control**

Because the temperature of a gas affects its density resulting in the amount of light absorbed by that gas, it is important to reduce the effect of fluctuations in ambient temperature on the M300E's measurement of CO for the M300E Analyzer. To accomplish this both the temperature of the sample chamber and the GFC Wheel are maintained at constant temperatures above their normal operating ranges.

Bench Temperature: To minimize the effects of ambient temperature variations on the sample measurement, the sample chamber is heated to 48°C (8 degrees above the maximum suggested ambient operating temperature for the analyzer). A strip heater attached to the underside of the chamber housing is the heat source. The temperature of the sample chamber is sensed by a thermistor, also attached to the sample chamber housing.

Wheel Temperature: To minimize the effects of temperature variations caused by the near proximity of the IR Source to the GFC Wheel on the gases contained in the wheel, it is also raised to a high temperature level. Because the IR Source itself is very hot, the set point for this heat circuit is 68°C. A cartridge heater implanted into the heat sync on the motor is the heat source. The temperature of the wheel/motor assembly is sensed by a thermistor also inserted into the heat sync.

Both heaters operate off of the AC line voltage supplied to the instrument.

11.5.3.2. **IR Source**

The light used to detect CO in the sample chamber is generated by an element heated to approximately 1100^{o}C producing infrared radiation across a broad band. This radiation is optically filtered after it has passed through the GFC Wheel and the sample chamber and just before it reaches the photo-detector to eliminate all black body radiation and other extraneous IR emitted by the various components of those components.

11.5.3.3. **GFC Wheel**

A synchronous AC motor turns the GFC Wheel motor. For analyzers operating on 60Hz line power this motor turns at 1800 rpm. For those operating on 50Hz line power the spin rate is 1500 rpm. The actual spin rate is unimportant within a large range since a phase lock loop circuit is used to generate timing pulses for signal processing.

In order to accurately interpret the fluctuations of the IR beam after it has passed through the sample gas, the GFC Wheel several other timing signals are produced by other photo emitters/detectors. These devices consist of a combination LED and detector mounted so that the light emitted by the LED shines through the same mask on the GFC Wheel that chops the IR beam.

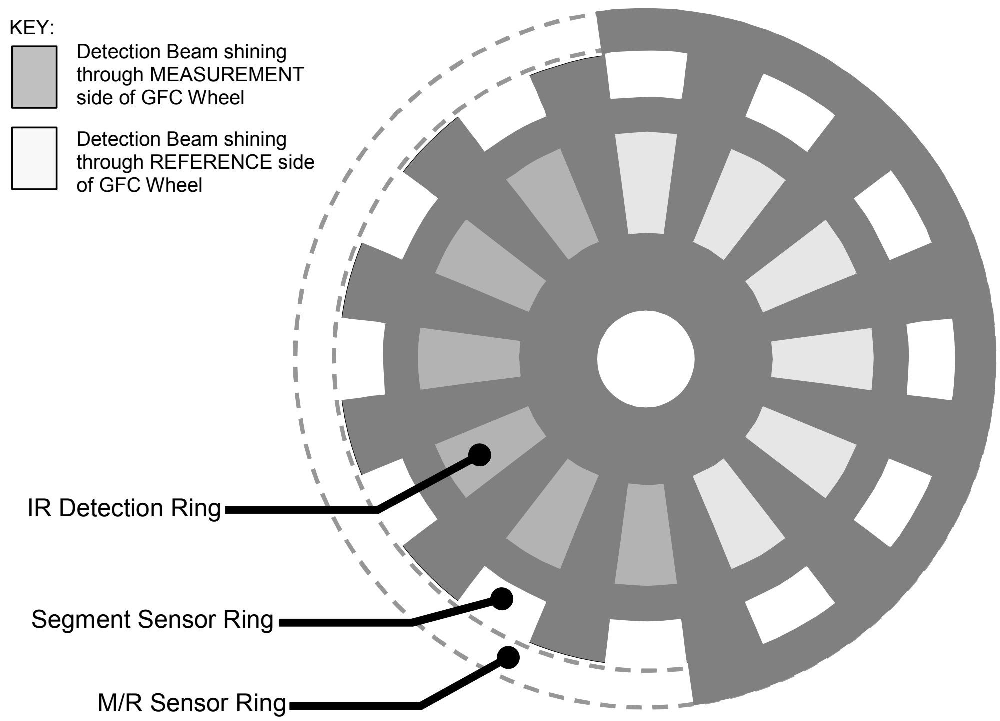


Figure 11-10: GFC Light Mask

M/R SENSOR

This emitter/detector assembly produces a signal that shines through a portion of the mask that allows light to pass for half of a full revolution of the wheel. The resulting light signal tells the analyzer whether the IR beam is shining through the measurement or the reference side of the GFC Wheel.

SEGMENT SENSOR

Light from this emitter/detector pair shines through a portion of the mask that is divided into the same number of segments as the IR detector ring. It is used by the synchronous/demodulation circuitry of the analyzer to latch onto the most stable part of each measurement and reference IR pulse.

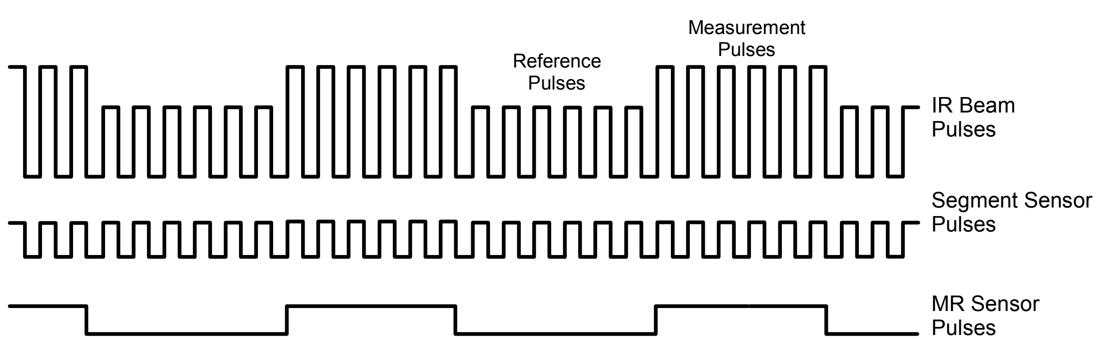


Figure 11-11: Segment Sensor and M/R Sensor Output

SCHMIDT TRIGGERS

To ensure that the waveforms produced by the Segment Sensor and the M/R Sensor are properly shaped and clean, these signals are passed through a set of Schmidt Triggers circuits.

11.5.3.4. IR Photo-Detector

The IR beam is converted into an electrical signal by a cooled solid-state photo-conductive detector. The detector is composed of a narrow-band optical filter, a piece of lead-salt crystal whose electrical resistance changes with temperature, and a two-stage thermo-electric cooler.

When the analyzer is on, a constant electrical current is directed through the detector. The IR beam is focused onto the detector surface, raising its temperature and lowering its electrical resistance that results in a change in the voltage drop across the detector.

During those times that the IR beam is bright, the temperature of the detector is high; the resistance of the detector is correspondingly low and its output voltage output is low. During those times when the IR beam intensity is low or completely blocked by the GFC Wheel mask, the temperature of the detector is lowered by the two-stage thermo-electric cooler, increasing the detector’s resistance and raising the output voltage.

11.5.4. SYNCHRONOUS DEMODULATOR (SYNC/DEMOD) ASSEMBLY

11.5.4.1. Overview

While the photo-detector converts fluctuations of the IR beam into electronic signals, the Sync/Demod Board amplifies these signals and converts them into usable information. Initially the output by the photo-detector is a complex and continuously changing waveform made up of Measure and Reference pulses. The sync/demod board demodulates this waveform and outputs two analog DC voltage signals, corresponding to the peak values of these pulses. **CO MEAS** and **CO REF** are converted into digital signals by circuitry on the motherboard, then used by the CPU to calculate the CO concentration of the sample gas.

Additionally the synch/demod board contains circuitry that controls the photo-detector’s thermoelectric cooler as well as circuitry for performing certain diagnostic tests on the analyzer.

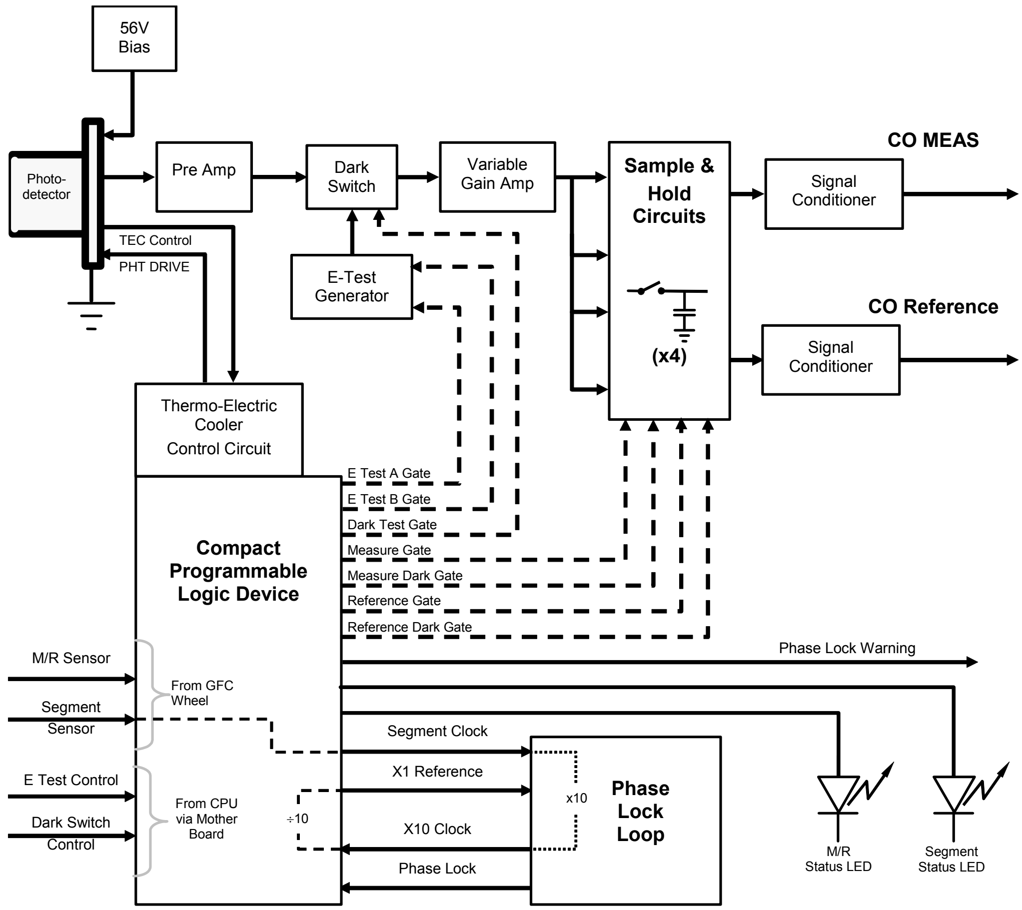


Figure 11-12: M300E/EM Sync/Demod Block Diagram

11.5.4.2. Signal Synchronization and Demodulation

The signal emitted by the IR photo-detector goes through several stages of amplification before it can be accurately demodulated. The first is a pre-amplification stage that raises the signal to levels readable by the rest of the sync/demod board circuitry. The second is a variable amplification stage that is adjusted at the factory to compensate for performance variations of mirrors, detectors, and other components of the optical bench from instrument to instrument.

The workhorses of the sync/demod board are the four sample-and-hold circuits that capture various voltage levels found in the amplified detector signal needed to determine the value of **CO MEAS** and **CO REF**. They are activated by logic signals under the control of a compact Programmable Logic Device (PLD), which in turn responds to the output of the Segment Sensor and M/R Sensor as shown in Figure 11-9.

The four sample and hold circuits are:

Table 11-2: Sync DEMOD Sample and Hold Circuits

Designation	Active When:	
	IR BEAM PASSING THROUGH	**Segment Sensor Pulse is:**
Measure Gate	MEASUREMENT cell of GFC Wheel	HIGH
Measure Dark Gate	MEASUREMENT Cell of GFC Wheel	LOW
Reference Gate	REFERENCE cell of GFC Wheel	HIGH
Reference Dark Gate	REFERENCE cell of GFC Wheel	LOW

Timing for activating the Sample and Hold Circuits is provided by a Phase Lock Loop (PLL) circuit. Using the segment sensor output as a reference signal the PLL generates clock signal at ten times that frequency. This faster clock signal is used by the PLD to make the Sample and Hold Circuits capture the signal during the center portions of the detected waveform, ignore the rising and falling edges of the detector signal.

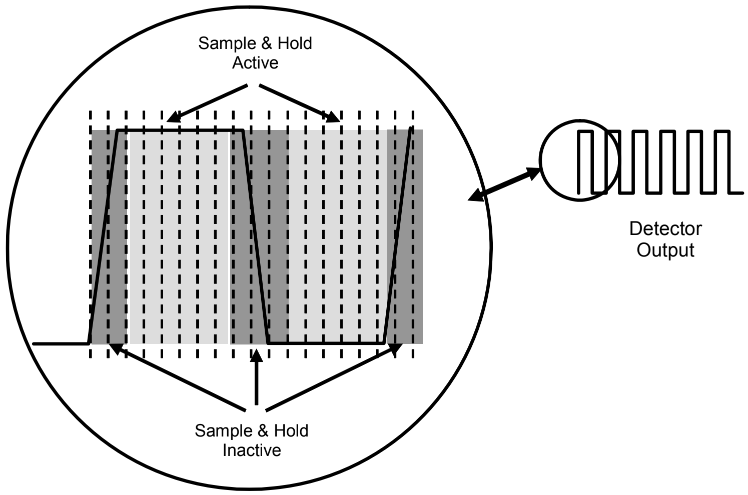


Figure 11-13: Sample & Hold Timing

11.5.4.3. **Sync/Demod Status LED's**

The following two status LED's located on the sync/demod board provide additional diagnostic tools for checking the GFC Wheel rotation.

Table 11-3: Sync/Demod Status LED Activity

LED	Function	Status OK	Fault Status
D1	M/R Sensor Status	LED flashes approximately 2/second	LED is stuck ON or OFF
D2	Segment Sensor Status	LED flashes approximately 6/second	LED is stuck ON or OFF

See Section 13.1.4.2 for more information.

11.5.4.4. **Photo-Detector Temperature Control**

The sync/demod board also contains circuitry that controls the IR photo-detector's Thermal Electric Coolers (TEC). A drive voltage, **PHT DRIVE**, is supplied to the coolers by the sync/demod board which is adjusted by the sync/demod board based on a return signal called TEC control which alerts the sync/demod board of the detector's temperature. The warmer the detector, the harder the coolers are driven.

PHT DRIVE is one of the Test Functions viewable by the user via the form panel. Press **<TST** or **TST>** until it appears on the display.

11.5.4.5. **Dark Calibration Switch**

This switch initiates the Dark Calibration procedure. When initiated by the user (See Section 9.6.1 for more details), the dark calibration process opens this switch, interrupting the signal from the IR photo-detector. This allows the analyzer to measure any offset caused by the sync/demod board circuitry.

11.5.4.6. **Electric Test Switch**

When active, this circuit generates a specific waveform intended to simulate the function of the IR photo-detector but with a known set of value which is substituted for the detector's actual signal via the dark switch. It may also be initiated by the user (See Section 7.4 for more details).

11.5.5. **RELAY BOARD**

By actuating various switches and relays located on this board, the CPU controls the status of other key components. The relay board receives instructions in the form of digital signals over the I^2C bus, interprets these digital instructions and activates its various switches and relays appropriately.

11.5.5.1. **Heater Control**

The two heaters attached to the sample chamber housing and the GFC Wheel motor are controlled by solid state relays located on the relay board.

The GFC Wheel heater is simply turned on or off, however control of the bench heater also includes circuitry that selects which one of its two separate heating elements is activated depending on whether the instrument is running on 100 VAC, 115 VAC or 230 VAC line power.

11.5.5.2. **GFC Wheel Motor Control:**

The GFC Wheel operates from a AC voltage supplied by a multi-input transformer located on the relay board. The step-down ratio of this transformer is controlled by factory-installed jumpers to adjust for 100 VAC, 115 VAC or 230 VAC line power. Other circuitry slightly alters the phase of the AC power supplied to the motor during start up based on whether line power is 50Hz or 60 Hz.

Normally, the GFC Wheel Motor is always turning while the analyzer is on. A physical switch located on the relay board can be used to turn the motor off for certain diagnostic procedures.

11.5.5.3. **Zero/Span Valve Options**

Any zero/span/shutoff valve options installed in the analyzer are controlled by a set of electronic switches located on the relay board. These switches, under CPU control, supply the +12VDC needed to activate each valve's solenoid.

11.5.5.4. **IR Source**

The relay board supplies a constant 11.5VDC to the IR Source. Under normal operation the IR source is always on.

11.5.5.5. **Status LED's**

Eight LED's are located on the analyzer's relay board to show the current status on the various control functions performed by the relay board. They are listed on Table 11-4.

Table 11-4: Relay Board Status LED's

LED	COLOR	FUNCTION	STATUS WHEN LIT	STATUS WHEN UNLIT
D1	RED	Watch Dog Circuit	Cycles On/Off Every 3 Seconds under direct control of the analyzer's CPU.	
D2	YELLOW	Wheel Heater	HEATING	NOT HEATING
D3	YELLOW	Bench Heater	HEATING	NOT HEATING
D4	YELLOW	Spare	N/A	N/A
D5	GREEN	Sample/Cal Gas Valve Option	Valve Open to CAL GAS FLOW	Valve Open to SAMPLE Gas Flow
D6	GREEN	Zero/Span Gas Valve Option	Valve Open to SPAN GAS FLOW	Valve Open to ZERO GAS FLOW
D7	GREEN	Shutoff Valve Option	Valve Open to CAL GAS FLOW	Valve CLOSED to CAL GAS FLOW
D8	GREEN	IR SOURCE	Source ON	Source OFF

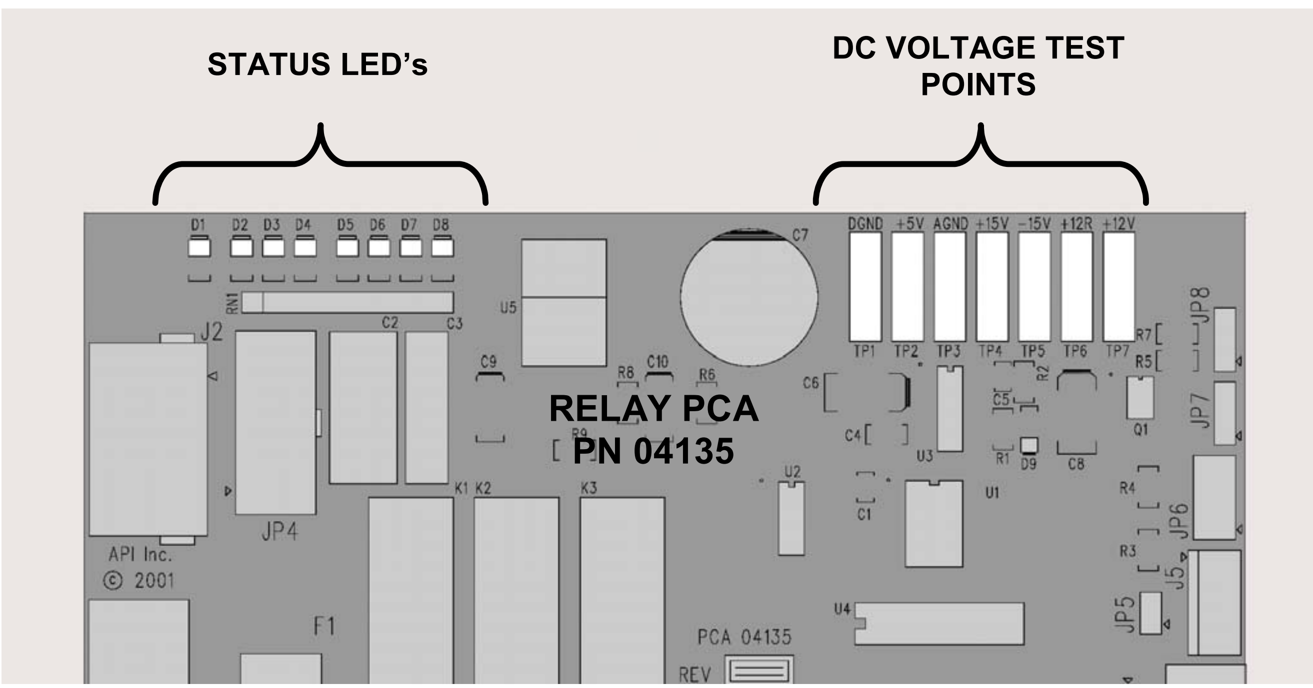


Figure 11-14: Location of relay board Status LED's

11.5.5.6. **I²C Watch Dog Circuitry**

Special circuitry on the relay board monitors the activity on the I²C bus and drives LED D1. Should this LED ever stay ON or OFF for 30 seconds, the watch dog circuit will automatically shut off all valves as well as turn off the IR Source and all heaters. The GFC Wheel motor will still be running as will the Sample Pump, which is not controlled by the relay board.

11.5.6. MOTHERBOARD

This printed circuit assembly provides a multitude of functions including, A/D conversion, digital input/output, PC-104 to I^2C translation, temperature sensor signal processing and is a pass through for the RS-232 and RS-485 signals.

11.5.6.1. A to D Conversion

Analog signals, such as the voltages received from the analyzer's various sensors, are converted into digital signals that the CPU can understand and manipulate by the analog to digital converter (A/D). Under the control of the CPU, this functional block selects a particular signal input (e.g. BOX TEMP, **CO MEAS**, **CO REF**, etc.) and then coverts the selected voltage into a digital word.

The A/D consists of a Voltage-to-Frequency (V-F) converter, a Programmable Logic Device (PLD), three multiplexers, several amplifiers and some other associated devices. The V-F converter produces a frequency proportional to its input voltage. The PLD counts the output of the V-F during a specified time period, and sends the result of that count, in the form of a binary number, to the CPU.

The A/D can be configured for several different input modes and ranges but in the M300E/EM is used in uni-polar mode with a +5 V full scale. The converter includes a 1% over and under-range. This allows signals from –0.05 V to +5.05 V to be fully converted.

For calibration purposes, two reference voltages are supplied to the A/D converter: Reference Ground and +4.096 VDC. During calibration, the device measures these two voltages, outputs their digital equivalent to the CPU. The CPU uses these values to compute the converter's offset and slope and uses these factors for subsequent conversions.

See Section 7.4.3 for instructions on performing this calibration.

11.5.6.2. Sensor Inputs

The key analog sensor signals are coupled to the A/D through the master multiplexer from two connectors on the motherboard. 100K terminating resistors on each of the inputs prevent cross talk from appearing on the sensor signals.

CO MEASURE AND REFERENCE

These are the primary signals that are used in the computation of the CO concentration. They are the demodulated IR-sensor signals from the sync demodulator board.

SAMPLE PRESSURE AND FLOW

These are analog signals from two sensors that measure the pressure and flow rate of the gas stream at the outlet of the sample chamber. This information is used in two ways. First, the sample pressure is used by the CPU to calculate CO concentration. Second, the pressure and flow rate are monitored as a test function to assist the user in predicting and troubleshooting failures.

11.5.6.3. Thermistor Interface

This circuit provides excitation, termination and signal selection for several negative-coefficient, thermistor temperature sensors located inside the analyzer. They are as follows:

SAMPLE TEMPERATURE SENSOR

The source of this signal is a thermistor located inside the sample chamber of the Optical Bench. It measures the temperature of the sample gas in the chamber. This data is used to during the calculation of the CO concentration value.

BENCH TEMPERATURE SENSOR

This thermistor is attached to the sample chamber housing. It reports the current temperature of the chamber housing to the CPU as part of the bench heater control loop.

WHEEL TEMPERATURE SENSOR

This thermistor is attached to the heatsink on the GFC Wheel motor assembly. It reports the current temperature of the wheel/motor assembly to the CPU as part of the Wheel Heater control loop.

BOX TEMPERATURE SENSOR

A thermistor is attached to the motherboard. It measures the analyzer's internal temperature. This information is stored by the CPU and can be viewed by the user for troubleshooting purposes via the front panel display (see Section 13.1.2).

11.5.6.4. Analog Outputs

The analyzer comes equipped with four analog outputs: **A1**, **A2**, **A3** and **A4**. The type of data and electronic performance of these outputs are configurable by the user (see Section 7.4).

OUTPUT LOOP-BACK

All four analog outputs are connected back to the A/D converter through a loop-back circuit. This permits the voltage outputs to be calibrated by the CPU without need for any additional tools or fixtures.

11.5.6.5. Internal Digital I/O

This channel is used to communicate digital status and control signals about the operation of key components of the Optical Bench. The CPU sends signals to the sync/demod board that initiate the **ELECTRICAL TEST** and **DARK CALIBRATION** procedures.

11.5.6.6. External Digital I/O

This External Digital I/O performs two functions.

STATUS OUTPUTS

Logic-Level voltages are output through an optically isolated 8-pin connector located on the rear panel of the analyzer. These outputs convey good/bad and on/off information about certain analyzer conditions. They can be used to interface with certain types of programmable devices (See Section 3.3.3).

CONTROL INPUTS

By applying +5VDC power supplied from an external source such as a PLC or Data logger (See Section 3.3.4), Zero and Span calibrations can be initiated by contact closures on the rear panel.

11.5.7. I^2C DATA BUS

An I^2C data bus is used to communicate data and commands between the CPU and the keyboard/display interface and the relay board. I^2C is a two-wire, clocked, digital serial I/O bus that is used widely in commercial and consumer electronic systems. A transceiver on the motherboard converts data and control signals from the PC-104 bus to I^2C. The data is then fed to the keyboard/display interface and finally onto the relay board.

Interface circuits on the keyboard/display interface and relay boards convert the I^2C data to parallel inputs and outputs. An additional, interrupt line from the keyboard to the motherboard allows the CPU to recognize and service key presses on the keyboard.

POWER UP CIRCUIT

This circuit monitors the +5V power supply during start-up and sets the analog outputs, external digital I/O ports, and I^2C circuitry to specific values until the CPU boots and the instrument software can establish control.

11.5.8. POWER SUPPLY/ CIRCUIT BREAKER

The analyzer operates on 100 VAC, 115 VAC or 230 VAC power at either 50Hz or 60Hz. Individual units are set up at the factory to accept any combination of these five attributes. As illustrated in Figure 11-13, power enters the analyzer through a standard IEC 320 power receptacle located on the rear panel of the instrument. From there it is routed through the ON/OFF Switch located in the lower right corner of the Front Panel. A 6.75 Amp circuit breaker is built into the ON/OFF Switch.

AC power is distributed directly to the sample gas pump. The bench and GFC Wheel heaters as well as the GFC Wheel receive AC power via the relay board.

AC Line power is converted stepped down and converted to DC power by two DC power supplies. One supplies +12 VDC, for valves and the IR source, while a second supply provides +5 VDC and ±15 VDC for logic and analog circuitry. All DC voltages are distributed via the relay board.

	**CAUTION** **GENERAL SAFETY HAZARD** **Should the AC power circuit breaker trip, investigate and correct the condition causing this situation before turning the analyzer back on.**

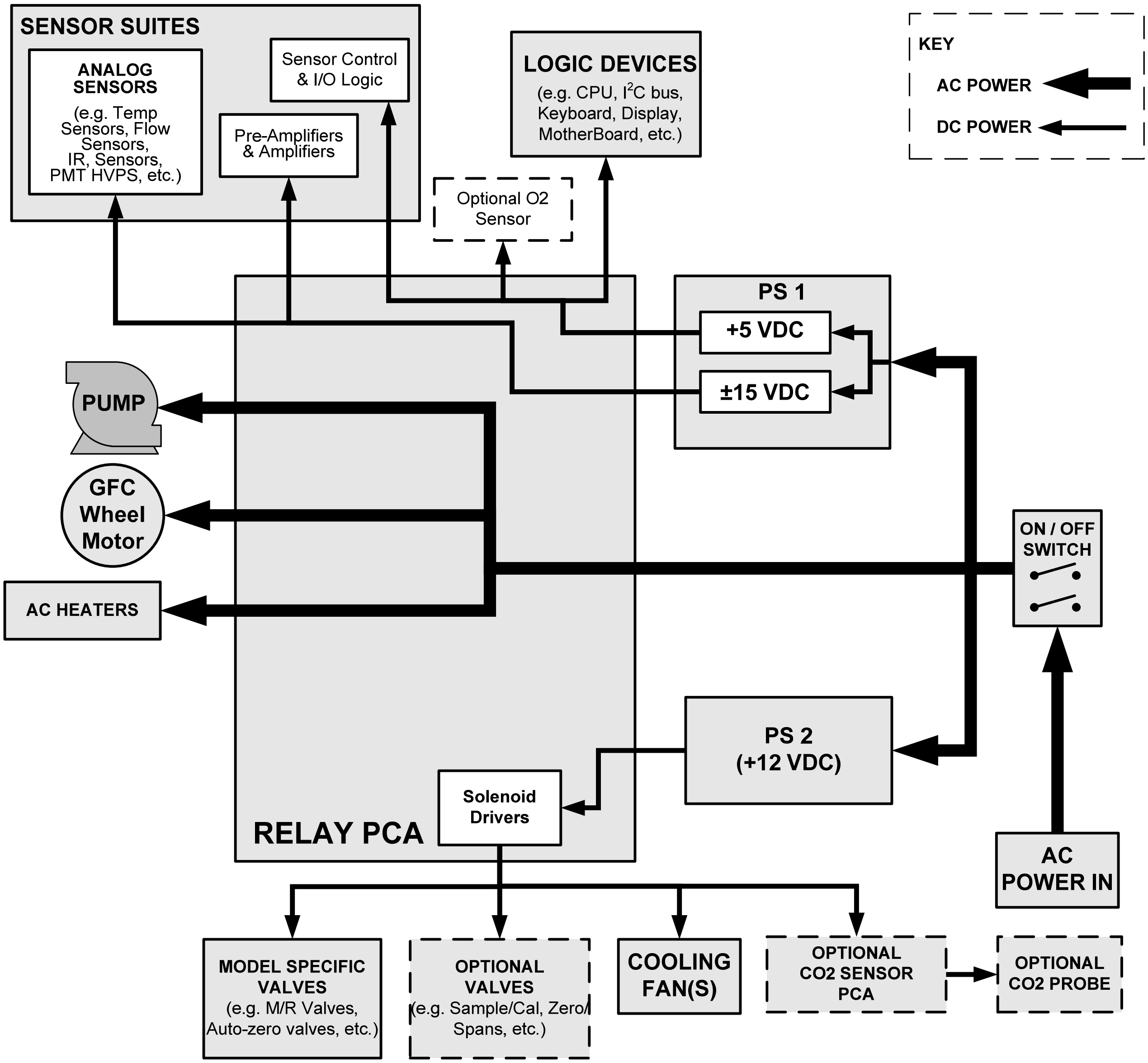


Figure 11-15: Power Distribution Block Diagram

11.5.9. **COMMUNICATION INTERFACE**

The analyzer has several ways to communicate to the outside world. Users can input data and receive information directly via the front panel keypad and display. Direct communication with the CPU is also available by way of the analyzer's RS-232 & RS-485 I/O ports or an optional Ethernet port. The analyzer can also send and receive different kinds of information via its external digital I/O connectors and the three analog outputs located on the rear panel.

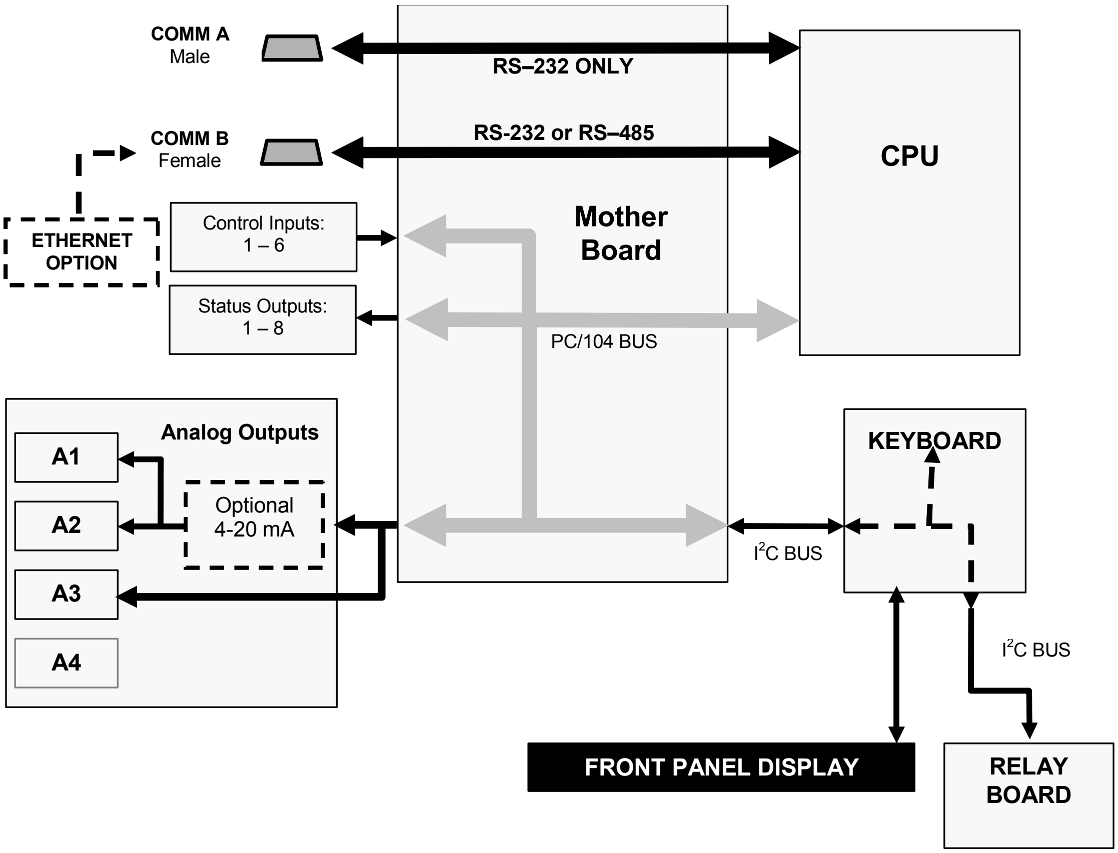


Figure 11-16: Interface Block Diagram

11.5.10. **FRONT PANEL INTERFACE**

The most commonly used method for communicating with the M300E/EM Analyzer is via the instrument's front panel which includes a set of three status LED's, a vacuum florescent display and a keyboard with 8 context sensitive keys.

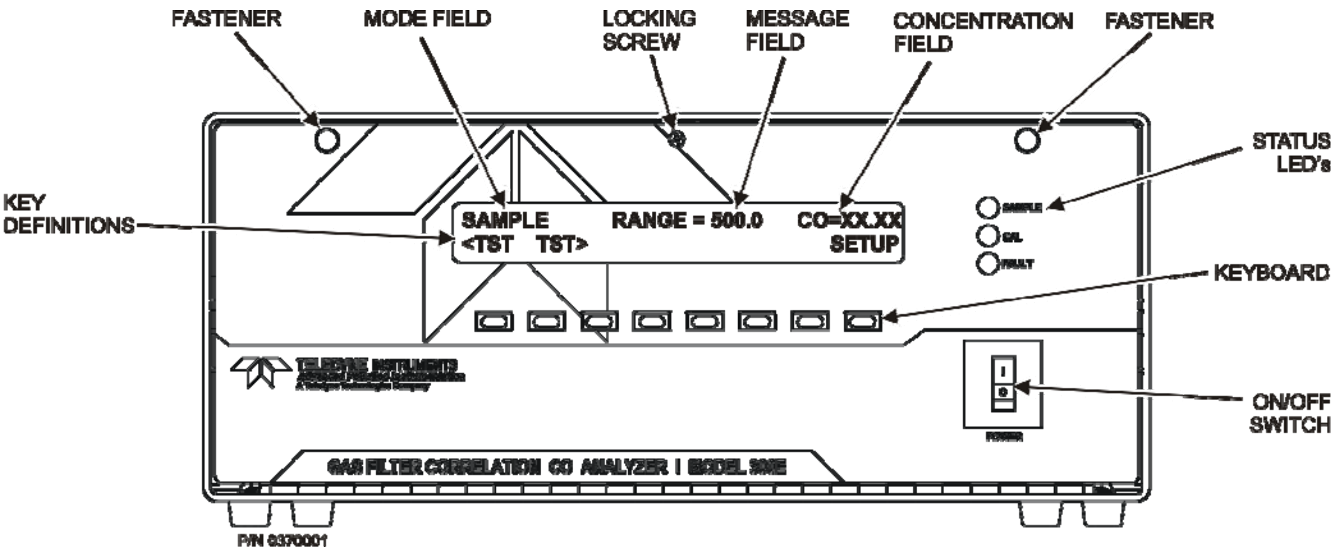


Figure 11-17: M300E/EM Front Panel Layout

11.5.10.1. **Analyzer Status LED's**

Three LED's are used to inform the user of the instrument's basic operating status. They are listed on Table 11-5 as follows:

Table 11-5: Front Panel Status LED's

NAME	COLOR	STATE	DEFINITION
SAMPLE	Green	Off	Unit is not operating in sample mode, iDAS is disabled.
		On	Sample Mode active; Front Panel Display being updated, iDAS data being stored.
		Blinking	Unit is operating in sample mode, front panel display being updated, iDAS hold-off mode is ON, iDAS disabled
CAL	Yellow	Off	Auto Cal disabled
		On	Auto Cal enabled
		Blinking	Unit is in calibration mode
FAULT	Red	Off	CO warnings exist
		Blinking	Warnings exist

11.5.10.2. **Keyboard**

A row of eight keys just below the vacuum florescent display (see Figure 11-15) is the main method by which the user interacts with the analyzer. As the software is operated, labels appear on the bottom row of the display directly above each active key, defining the function of that key as it is relevant for the operation being performed. Pressing a key causes the associated instruction to be performed by the analyzer.

Note that the keys do not auto-repeat. In circumstances where the same key must be activated for two consecutive operations, it must be released and re-pressed.

11.5.10.3. **Display**

The main display of the analyzer is a vacuum florescent display with two lines of 40 text characters each. Information is organized in the following manner (see Figure 11-17):

- **Mode Field**: Displays the name of the analyzer's current operating mode.
- **Message Field**: Displays a variety of informational messages such as warning messages, operation data and response messages during interactive tasks.
- **Concentration Field**: Displays the actual concentration of the sample gas currently being measured by the analyzer.
- **Keypad Definition Field**: Displays the definitions for the row of keys just below the display. These definitions are dynamic, context sensitive and software driven.

11.5.10.4. **Keyboard/Display Interface Electronics**

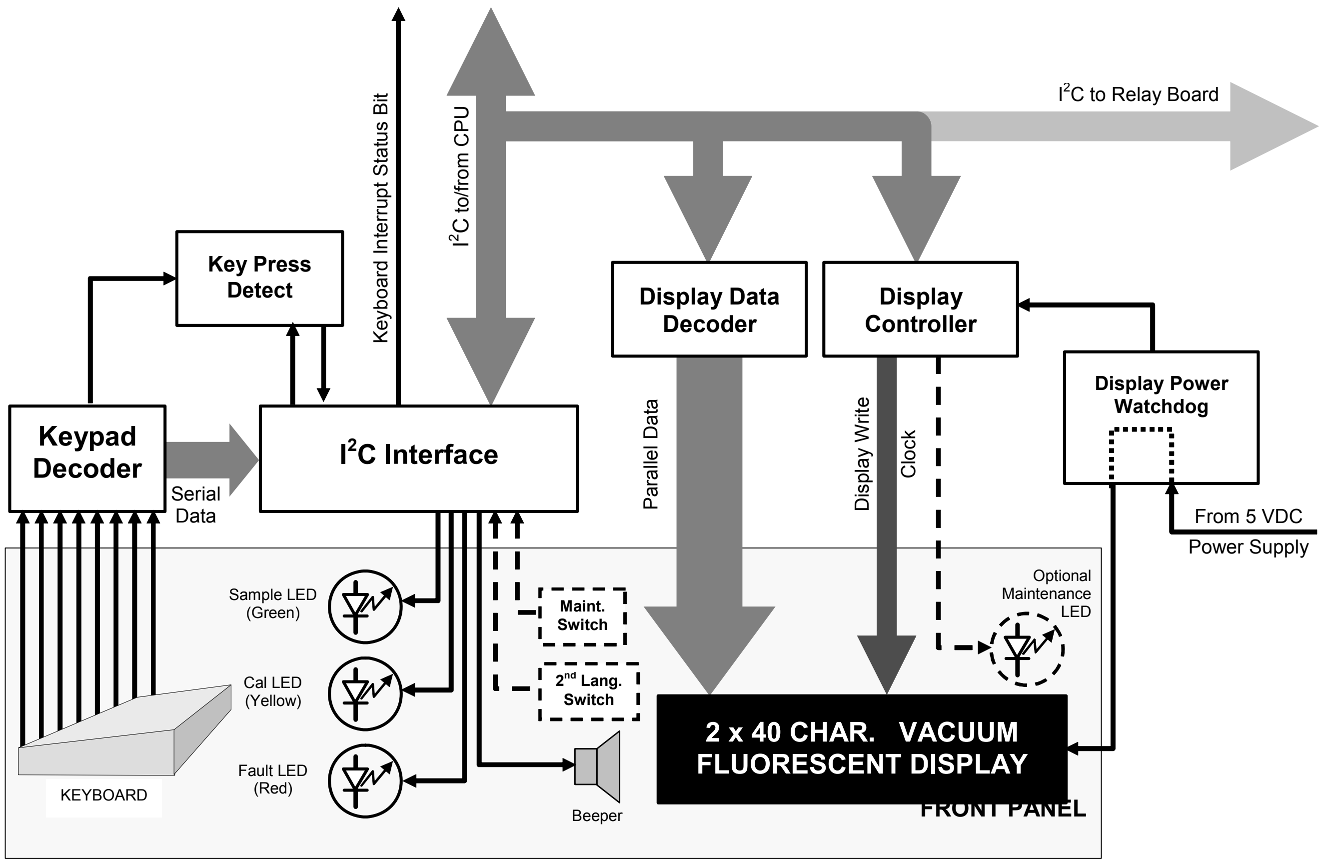


Figure 11-18: Keyboard and Display Interface Block Diagram

The keyboard/display interface electronics of the M300E/EM Analyzer watches the status of the eight front panel keys, alerts the CPU when keys are depressed, translates data from parallel to serial and back and manages communications between the keyboard, the CPU and the front panel display. Except for the Keyboard interrupt status bit, all communication between the CPU and the keyboard/display is handled by way of the instrument's I^2C bus. The CPU controls the clock signal and determines when the various devices on the bus are allowed to talk or required to listen. Data packets are labeled with addresses that identify for which device the information is intended.

KEYPAD DECODER

Each key on the front panel communicates with a decoder IC via a separate analog line. When a key is depressed the decoder chip notices the change of state of the associated signal; latches and holds the state of all eight lines (in effect creating an 8-bit data word); alerts the key-depress-detect circuit (a flip-flop IC); translates the 8-bit word into serial data and; sends this to the I^2C interface chip.

KEY-DEPRESS-DETECT CIRCUIT

This circuit flips the state of one of the inputs to the I^2C interface chip causing it to send an interrupt signal to the CPU

I^2C INTERFACE CHIP

This IC performs several functions:

- Using a dedicated digital status bit, it sends an interrupt signal alerting the CPU that new data from the keyboard is ready to send.
- Upon acknowledgement by the CPU that it has received the new keyboard data the I^2C interface chip resets the key-depress-detect flip-flop.
- In response to commands from the CPU, it turns the front panel status LEDs on and off and activates the beeper.
- Informs the CPU when the optional maintenance and second language switches have been opened or closed (see Section 5 for information on these options).

DISPLAY DATA DECODER

This decoder the serial translates the data sent by the CPU (in TTY format) into a bitmapped image which is sent over a parallel data bus to the display.

DISPLAY CONTROLLER

This circuit manages the interactions between the display data decoder and the display itself. It generates a clock pulse that keeps the two devices synchronized. It can also, in response to commands from the CPU turn off and/or reset the display.

Additionally, for analyzers with the optional maintenance switch is installed (see Section 5), the display controller turns on an LED located on the back of the keyboard interface PCA whenever the instrument is placed in maintenance mode.

DISPLAY POWER WATCH DOG

The M300E Analyzer's display can begin to show garbled information or lock-up if the DC voltage supplied to it falls too low, even momentarily. To alleviate this, a brownout watch dog circuit monitors the level of the power supply and in the event that the voltage level falls below a certain level, turns the display off, then on resetting it

I^2C LINK TO THE RELAY PCA

While the CPU's I^2C communication with the relay board is also routed through the keyboard/display interface, information passed to and from the relay board via this channel is not recognized by, acted upon or affected by the circuitry of the keyboard/display interface.

11.5.11. **SOFTWARE OPERATION**

The M300E/EM Gas Filter Correlation Carbon Monoxide Analyzer has at its heart a high performance, 386-based microcomputer running MS-DOS. Inside the DOS shell, special software developed by Teledyne API interprets user commands via the various interfaces, performs procedures and tasks, stores data in the CPU's various memory devices and calculates the concentration of the sample gas.

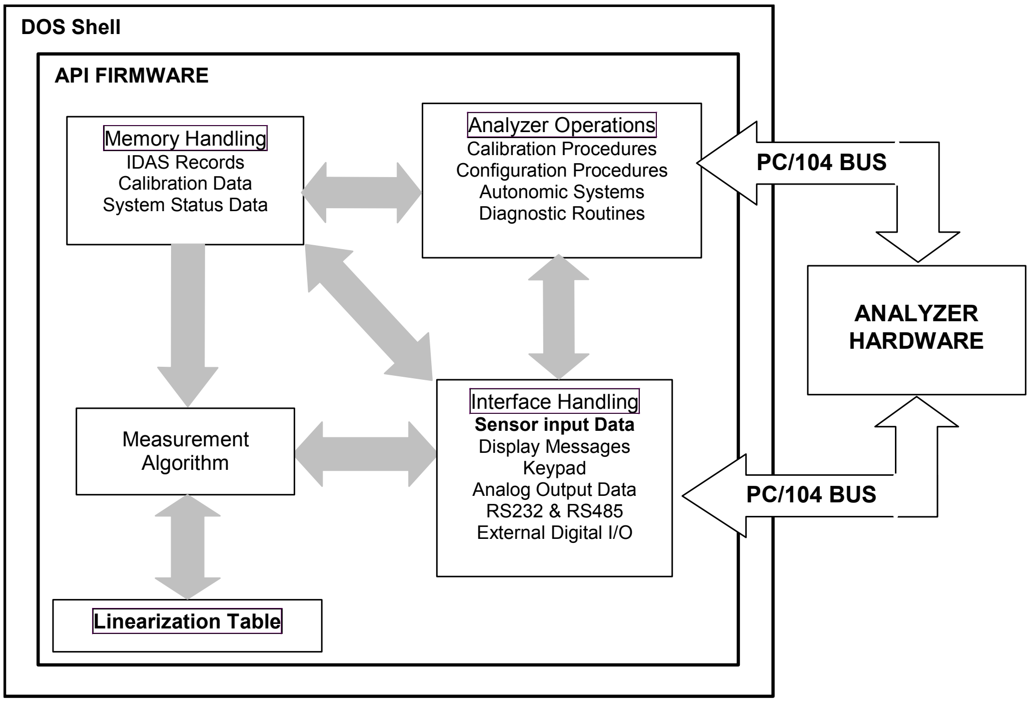


Figure 11-19: Basic Software Operation

11.5.12. **ADAPTIVE FILTER**

The M300E/EM software processes the **CO MEAS** and **CO REF** signals, after they are digitized by the motherboard, through an adaptive filter built into the software. Unlike other analyzers that average the output signal over a fixed time period, the M300E/EM averages over a set number of samples, where each sample is 0.2 seconds. This technique is known as boxcar averaging. During operation, the software automatically switches between two different length filters based on the conditions at hand. Once triggered, the short filter remains engaged for a fixed time period to prevent chattering.

During conditions of constant or nearly constant concentration the software, by default, computes an average of the last 750 samples, or approximately 150 seconds. This provides the calculation portion of the software with smooth stable readings. If a rapid change in concentration is detected the filter includes, by default, the last 48 samples, approximately 10 seconds of data, to allow the analyzer to more quickly respond. If necessary, these boxcar lengths can be changed between 1 and 1000 samples but with corresponding tradeoffs in rise time and signal-to-noise ratio (contact customer service for more information).

Two conditions must be simultaneously met to switch to the short filter. First the instantaneous concentration must exceed the average in the long filter by a fixed amount. Second the instantaneous concentration must exceed the average in the long filter by a portion, or percentage, of the average in the long filter.

11.5.13. CALIBRATION - SLOPE AND OFFSET

Calibration of the analyzer is performed exclusively in software.

During instrument calibration (see Section 9) the user enters expected values for zero and span via the front panel keypad and commands the instrument to make readings of calibrated sample gases for both levels. The readings taken are adjusted, linearized, and compared to the expected values. With this information the software computes values for instrument slope and offset and stores these values in memory for use in calculating the CO concentration of the sample gas.

The instrument slope and offset values recorded during the last calibration are available for viewing from the from the front panel (see Section 3.5.4).

11.5.14. MEASUREMENT ALGORITHM

Once the IR photo-detector signal is demodulated into **CO MEAS** and **CO REF** by the sync/demod board and converted to digital data by the motherboard, the M300E/EM analytical software calculates the ratio between **CO MEAS** and **CO REF**. This value is compared to a look-up table that is used, with interpolation, to linearize the response of the instrument. The linearized concentration value is combined with calibration slope and offset values, then normalized for changes in sample gas pressure to produce the final CO concentration. This is the value that is displayed on the instrument front panel display and is stored in memory by the analyzer's iDAS system.

11.5.15. TEMPERATURE AND PRESSURE COMPENSATION

Changes in pressure can have a noticeable, effect on the CO concentration calculation. To account for this, the M300E/EM software includes a feature which allows the instrument to compensate for the CO calculations based on changes in ambient pressure.

The TPC feature multiplies the analyzer's CO concentration by a factor which is based on the difference between the ambient pressure of the sample gas normalized to standard atmospheric pressure. As ambient pressure increases, the compensated CO concentration is decreased.

11.5.16. INTERNAL DATA ACQUISITION SYSTEM (IDAS)

The iDAS is designed to implement predictive diagnostics that stores trending data for users to anticipate when an instrument will require service. Large amounts of data can be stored in non-volatile memory and retrieved in plain text format for further processing with common data analysis programs. The iDAS has a consistent user interface in all Teledyne API analyzers. New data parameters and triggering events can be added to the instrument as needed.

Depending on the sampling frequency and the number of data parameters the iDAS can store several months of data, which are retained even when the instrument is powered off or a new firmware is installed. The iDAS permits users to access the data through the instrument's front panel or the remote interface. The latter can automatically download stored data for further processing. For information on using the iDAS, refer to Section 7.1.

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12. MAINTENANCE SCHEDULE & PROCEDURES

Predictive diagnostic functions, including data acquisition records, failure warnings and test functions built into the analyzer, allow the user to determine when repairs are necessary without performing painstaking preventative maintenance procedures. There are, however, a minimal number of simple procedures that when performed regularly will ensure that the analyzer continues to operate accurately and reliably over its lifetime. Repairs and troubleshooting are covered in Section **Error! Reference source not found.** of this manual.

12.1. MAINTENANCE SCHEDULE

Table 12-1 shows a typical maintenance schedule for the analyzer. Please note that in certain environments (i.e. dusty, very high ambient pollutant levels) some maintenance procedures may need to be performed more often than shown.

NOTE

A Span and Zero Calibration Check (see CAL CHECK REQ'D Column of Table 12-1) must be performed following certain of the maintenance procedure listed below.

See Sections 9.3 and 9.4 for instructions on performing checks.

	**CAUTION** **GENERAL SAFETY HAZARD** **Risk of electrical shock. Disconnect power before performing any of the following operations that require entry into the interior of the analyzer.**

	**CAUTION** **QUALIFIED PERSONNEL** **The operations outlined in this section are to be performed by qualified maintenance personnel only.**

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Table 12-1: M300E/EM Maintenance Schedule

ITEM	ACTION	FREQ	CAL CHECK REQ'D	MANUAL	DATE PERFORMED									
Particulate Filter	Replace	Weekly or As Needed	No											
Verify Test Functions	Record and Analyze	Weekly or after any Maintenance or Repair	No											
Pump Diaphragm	Replace	Annually	Yes											
Perform Flow Check	Check Flow	Annually	No											
Perform Leak Check	Verify Leak Tight	Annually or after any Maintenance or Repair	No											
Pneumatic lines	Examine and Clean	As Needed	Yes if cleaned											
Cleaning	Clean	As Needed	Only if cover removed											

Table 12-2: M300E/EM Test Function Record

FUNCTION	OPERATING MODE*	DATE RECORDED											
STABILITY	ZERO CAL												
CO MEAS	ZERO CAL												
MR RATIO	ZERO CAL												
	SPAN CAL												
PRES	SAMPLE												
PHT DRIVE	SAMPLE AFTER WARM-UP												
SLOPE	SPAN CAL												
OFFSET	ZERO CAL												

12.2. PREDICTING FAILURES USING THE TEST FUNCTIONS

The Test Functions can be used to predict failures by looking at how their values change over time. Initially it may be useful to compare the state of these Test Functions to the values recorded on the printed record of the final calibration performed on your instrument at the factory, P/N 04307. Table 12-3 can be used as a basis for taking action as these values change with time. The internal data acquisition system (iDAS) is a convenient way to record and track these changes. Use APICOM to download and review this data from a remote location.

Table 12-3: Predictive uses for Test Functions

<table>
<tr><th>FUNCTION</th><th>CONDITION</th><th>BEHAVIOR</th><th>INTERPRETATION</th></tr>
<tr><td>STABILITY</td><td>Zero Cal</td><td>Increasing</td><td>• Pneumatic Leaks – instrument & sample system
• Detector deteriorating</td></tr>
<tr><td>CO MEAS</td><td>Zero Cal</td><td>Decreasing</td><td>• Source Aging
• Detector deteriorating
• Optics getting dirty or contaminated</td></tr>
<tr><td rowspan="4">MR RATIO</td><td rowspan="2">Zero Cal</td><td>Increasing</td><td>• Source Aging
• Detector deteriorating
• Contaminated zero gas (H_2O)</td></tr>
<tr><td>Decreasing</td><td>• Source Aging
• Detector deteriorating
• GFC Wheel Leaking
• Pneumatic Leaks
• Contaminated zero gas (CO)</td></tr>
<tr><td rowspan="2">Span Cal</td><td>Increasing</td><td>• Source Aging
• Pneumatic Leaks – instrument & sample system
• Calibration system deteriorating
• GFC Wheel Leaking</td></tr>
<tr><td>Decreasing</td><td>• Source Aging
• Calibration system deteriorating</td></tr>
<tr><td rowspan="2">PRES</td><td rowspan="2">Sample</td><td>Increasing > 1”</td><td>• Pneumatic Leak between sample inlet and Sample Cell
• Change in sampling manifold</td></tr>
<tr><td>Decreasing > 1”</td><td>• Dirty particulate filter
• Pneumatic obstruction between sample inlet and Sample Cell
• Obstruction in sampling manifold</td></tr>
<tr><td>PHT DRIVE</td><td>Any, but with Bench Temp at 48°C</td><td>Increasing</td><td>• Mechanical Connection between IR-Detector and Sample Cell deteriorating
• IR-Photodetector deteriorating</td></tr>
<tr><td rowspan="2">OFFSET</td><td rowspan="2">Zero Cal</td><td>Increasing</td><td>• See MR Ratio - Zero Cal Decreasing above</td></tr>
<tr><td>Decreasing</td><td>• See MR Ratio - Zero Cal Increasing above</td></tr>
<tr><td rowspan="2">SLOPE</td><td rowspan="2">Span Cal</td><td>Increasing</td><td>• See MR Ratio - Span Cal Decreasing above</td></tr>
<tr><td>Decreasing</td><td>• See MR Ratio – Span Cal Increasing above</td></tr>
</table>

12.3. MAINTENANCE PROCEDURES

The following procedures are to be performed periodically as part of the standard maintenance of the M300E.

12.3.1. REPLACING THE SAMPLE PARTICULATE FILTER

The particulate filter should be inspected often for signs of plugging or contamination. We recommend that the filter and the wetted surfaces of the filter housing are handled as little as possible when you change the filter. Do not touch any part of the housing, filter element, PTFE retaining ring, glass cover and the o-ring.

To change the filter:

1. Turn OFF the analyzer to prevent drawing debris into the instrument.
2. Open the M300E Analyzer's hinged front panel and unscrew the knurled retaining ring on the filter assembly.

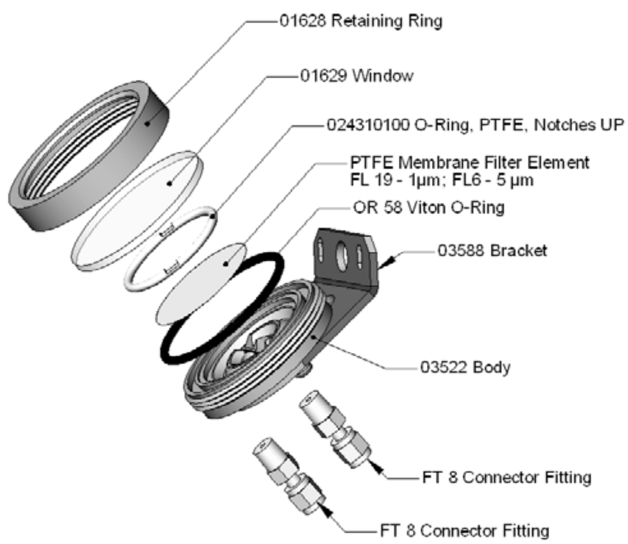


Figure 12-1: Sample Particulate Filter Assembly

3. Carefully remove the retaining ring, PTFE o-ring, glass filter cover and filter element.
4. Replace the filter, being careful that the element is fully seated and centered in the bottom of the holder.
5. Re-install the PTFE o-ring (with the notches up), the glass cover, then screw on the retaining ring and hand tighten. Inspect the seal between the edge of filter and the o-ring to assure a proper seal.
6. Re-start the Analyzer.

12.3.2. REBUILDING THE SAMPLE PUMP

The diaphragm in the sample pump periodically wears out and must be replaced. A sample rebuild kit is available – see label on pump for the part number of the pump rebuild kit. Instructions and diagrams are included with the kit.

Always perform a Flow and Leak Check after rebuilding the Sample Pump.

12.3.3. PERFORMING LEAK CHECKS

Leaks are the most common cause of analyzer malfunction; Section 12.3.3.1 presents a simple leak check procedure. Section 12.3.3.2 details a more thorough procedure.

12.3.3.1. Vacuum Leak Check and Pump Check

This method is easy and fast. It detects, but does not locate most leaks. It also verifies that the sample pump is in good condition.

1. Turn the analyzer ON, and allow enough time for flows to stabilize.
2. Cap the sample inlet port.
3. After several minutes, when the pressure has stabilized, scroll through the **TEST** menu, note the SAMPLE PRESSURE reading.
4. If the reading is < 10 in-Hg, the pump is in good condition and there are no large leaks.
5. Check the sample gas flow. If the flow is <10 cm^3/min and stable, there are no large leaks in the instrument's pneumatics.

12.3.3.2. Pressure Leak Check

If you can't locate the leak by the above procedure, use the following procedure. Obtain a leak checker similar to the Teledyne API P/N 01960, which contains a small pump, shut-off valve and pressure gauge. Alternatively, a convenient source of low-pressure gas is a tank of span gas, with the two-stage regulator adjusted to less than 15 psi with a shutoff valve and pressure gauge.

CAUTION

GENERAL SAFETY HAZARD

Do not use bubble solution with vacuum applied to the analyzer. The solution may contaminate the instrument. Do not exceed 15 PSIG pressure.

6. Turn OFF power to the instrument.
7. Install a leak checker or tank of gas as described above on the sample inlet at the rear panel.
8. Remove the instrument cover and locate the inlet side of the sample pump. Remove the flow assembly from the pump and plug it with the appropriate gas-tight fitting.
9. Pressurize the instrument with the leak checker, allowing enough time to fully pressurize the instrument through the critical flow orifice. Check each fitting with soap bubble solution, looking for bubbles. Once the fittings have been wetted with soap solution, do not re-apply vacuum, as it will suck soap solution into the instrument and contaminate it. Do not exceed 15 psi pressure.
10. If the instrument has one of the zero and span valve options, the normally closed ports on each valve should also be separately checked. Connect the leak checker to the normally closed ports and check with soap bubble solution.
11. Once the leak has been located and repaired, the leak-down rate should be < 1 in-Hg (0.4 psi) in 5 minutes after the pressure is shut off.

12.3.4. PERFORMING A SAMPLE FLOW CHECK

CAUTION

GENERAL SAFETY HAZARD

Always use a separate calibrated flow meter capable of measuring flows in the 0 – 1000 cm^3/min range to measure the gas flow rate though the analyzer.

DO NOT use the built in flow measurement viewable from the Front Panel of the instrument. This measurement is only for detecting major flow interruptions such as clogged or plugged gas lines.

See Figure 3-2 for sample port location.

1. Attach the Flow Meter to the sample inlet port on the rear panel. Ensure that the inlet to the Flow Meter is at atmospheric pressure.
2. Sample flow should be 800 cm^3/min ± 10%.
3. Once an accurate measurement has been recorded by the method described above, adjust the analyzer's internal flow sensors (See Section 9.6.3).

Low flows indicate blockage somewhere in the pneumatic pathway, typically a plugged sintered filter or critical flow orifice in one of the analyzer's flow control assemblies. High flows indicate leaks downstream of the Flow Control Assembly.

12.3.5. CLEANING THE OPTICAL BENCH

The M300E/EM sensor assembly and optical bench are complex and delicate. Disassembly and cleaning is not recommended. Please check with the factory before disassembling the optical bench.

12.3.6. CLEANING EXTERIOR SURFACES OF THE M300E/EM

If necessary, the exterior surfaces of the M300E/EM can be cleaned with a clean damp cloth. Do not submerge any part of the instrument in water or cleaning solution.

13. TROUBLESHOOTING & REPAIR

This contains a variety of methods for identifying the source of performance problems with the analyzer. Also included in this are procedures that are used in repairing the instrument.

NOTE

QUALIFIED PERSONNEL

The operations outlined in this section must be performed by qualified maintenance personnel only.

CAUTION

GENERAL SAFETY HAZARD

- **Risk of electrical shock. Some operations need to be carried out with the instrument open and running.**
- **Exercise caution to avoid electrical shocks and electrostatic or mechanical damage to the analyzer.**
- **Do not drop tools into the analyzer or leave those after your procedures.**
- **Do not shorten or touch electric connections with metallic tools while operating inside the analyzer.**
- **Use common sense when operating inside a running analyzer.**

13.1. GENERAL TROUBLESHOOTING

The M300E/EM Carbon Monoxide Analyzer has been designed so that problems can be rapidly detected, evaluated and repaired. During operation, it continuously performs diagnostic tests and provides the ability to evaluate its key operating parameters without disturbing monitoring operations.

A systematic approach to troubleshooting will generally consist of the following five steps:

1. Note any **WARNING MESSAGES** and take corrective action as necessary.
2. Examine the values of all TEST functions and compare them to factory values. Note any major deviations from the factory values and take corrective action.
3. Use the internal electronic status LED’s to determine whether the electronic communication channels are operating properly.

   Verify that the DC power supplies are operating properly by checking the voltage test points on the relay PCA.

   Note that the analyzer’s DC power wiring is color-coded and these colors match the color of the corresponding test points on the relay PCA.
4. **SUSPECT A LEAK FIRST!**

   Customer service data indicate that the majority of all problems are eventually traced to leaks in the internal pneumatics of the analyzer or the diluent gas and source gases delivery systems.

   Check for gas flow problems such as clogged or blocked internal/external gas lines, damaged seals, punctured gas lines, a damaged / malfunctioning pumps, etc.
5. Follow the procedures defined in Section 13.5 to confirm that the analyzer’s vital functions are working (power supplies, CPU, relay PCA, keyboard, PMT cooler, etc.).
   - See Figure 3-4 for the general layout of components and sub-assemblies in the analyzer.
   - See the wiring interconnect diagram and interconnect list in Appendix D.

13.1.1. FAULT DIAGNOSIS WITH WARNING MESSAGES

The most common and/or serious instrument failures will result in a warning message being displayed on the front panel. Table 13-1 lists warning messages, along with their meaning and recommended corrective action.

It should be noted that if more than two or three warning messages occur at the same time, it is often an indication that some fundamental analyzer sub-system (power supply, relay board, motherboard) has failed rather than indication of the specific failures referenced by the warnings. In this case, it is recommended that proper operation of power supplies (See Section 13.5.2), the relay board (See Section 13.5.5), and the A/D Functions (see Section **Error! Reference source not found.**) be confirmed before addressing the specific warning messages.

The analyzer will alert the user that a Warning Message is active by displaying the keypad label MSG on the Front Panel. In this case the Front panel display will look something like the following:

SAMPLE BENCH TEMP WARNING CO = XXX.0
TEST CAL MSG CLR SETUP

The analyzer will also alert the user via the Serial I/O COM port(s) and cause the FAULT LED on the front panel to blink.

To view or clear the various warning messages press:

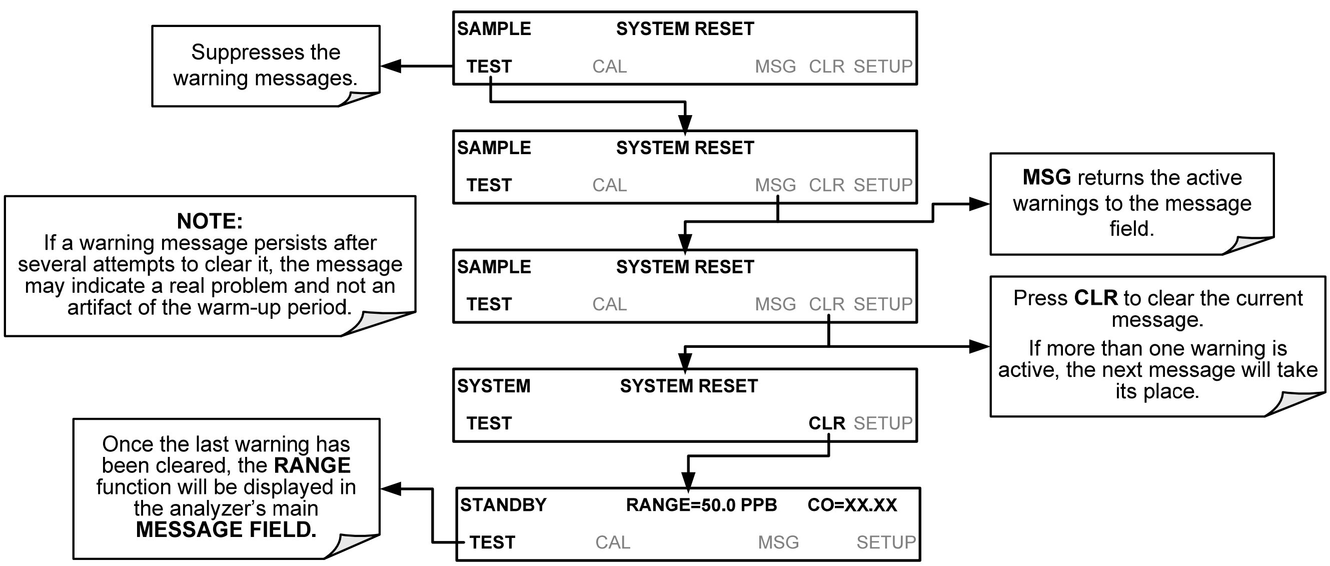


Figure 13-1: Viewing and Clearing Warning Messages

Table 13-1: Warning Messages - Indicated Failures

WARNING MESSAGE	FAULT CONDITION	POSSIBLE CAUSES
BENCH TEMP WARNING	The optical bench temp is controlled at 48 ± 2 °C.	Bad bench heater Bad bench temperature sensor Bad relay controlling the bench heater Entire relay board is malfunctioning I^2C bus malfunction
BOX TEMP WARNING	Box Temp is < 5 °C or > 48 °C.	NOTE: Box temperature typically runs ~7°C warmer than ambient temperature. Poor/blocked ventilation to the analyzer. Stopped exhaust-fan Ambient temperature outside of specified range
CANNOT DYN SPAN	Dynamic Span operation failed	Measured concentration value is too high or low. Concentration slope value to high or too low
CANNOT DYN ZERO	Dynamic Zero operation failed	Measured concentration value is too high. Concentration offset value to high.
CONFIG INITIALIZED	Configuration and Calibration data reset to original Factory state.	Failed disk on chip User erased data
DATA INITIALIZED	Data Storage in iDAS was erased	Failed disk on chip User cleared data
FRONT PANEL WARN	The CPU is unable to Communicate with the Front Panel Display /Keyboard	Warning only appears on serial I/O com port(s) Front panel display will be frozen, blank or will not respond. Failed keyboard I^2C bus failure Loose connector/wiring
PHOTO TEMP WARNING	PHT DRIVE is >4800 mVDC	Failed IR photo-detector Failed sync/demod board IR photo-detector improperly attached to the sample chamber Bench temp too high.
REAR BOARD NOT DET	Motherboard not detected on power up.	Warning only appears on serial I/O com port(s) Front panel display will be frozen, blank or will not respond. Massive failure of motherboard
RELAY BOARD WARN	The CPU cannot communicate with the Relay Board.	I^2C bus failure Failed relay board Loose connectors/wiring
SAMPLE FLOW WARN	Sample flow rate is < 500 cm^3/min or > 1000 cm^3/min.	Failed sample pump Blocked sample inlet/gas line Dirty particulate filter Leak downstream of critical flow orifice Failed flow sensor/circuitry
SAMPLE PRES WARN	Sample Pressure is <10 in-Hg or > 35 in-Hg Normally 29.92 in-Hg at sea level decreasing at 1 in-Hg per 1000 ft of altitude (with no flow – pump disconnected).	If sample pressure is < 10 in-hg: Blocked particulate filter Blocked sample inlet/gas line Failed pressure sensor/circuitry If sample pressure is > 35 in-hg: Pressurized sample gas. Install vent Blocked vent line on pressurized sample/zero/span gas supply Bad pressure sensor/circuitry

Table 13-1: Warning Messages – Indicated Failures (cont.)

WARNING MESSAGE	FAULT CONDITION	POSSIBLE CAUSES
SAMPLE TEMP WARN	Sample temperature is < 10°C or > 100°C.	Ambient temperature outside of specified range Failed bench heater Failed bench temperature sensor Relay controlling the bench heater Failed relay board I^2C bus
SOURCE WARNING	Occurs when CO Ref is <1250 mVDC or >4950 mVDC. Either of these conditions will result in an invalid M/R ratio.	GFC Wheel stopped Failed sync/demod board If status LED's on the sync/demod board ARE flashing the cause is most likely a failed: IR source Relay board I^2C bus IR photo-detector
SYSTEM RESET	The computer has rebooted.	This message occurs at power on. If you have not cycled the power on your instrument: Failed +5 VDC power, Fatal error caused software to restart Loose connector/wiring
WHEEL TEMP WARNING	The filter wheel temperature is controlled at 68 ± 2 °C	Blocked cooling vents below GFC Assembly. Make sure that adequate clear space beneath the analyzer. Analyzer's top cover removed Wheel heater Wheel temperature sensor Relay controlling the wheel heater Entire relay board I^2C bus

13.1.2. FAULT DIAGNOSIS WITH TEST FUNCTIONS

Besides being useful as predictive diagnostic tools, the test functions viewable from the front panel can be used to isolate and identify many operational problems when combined with a thorough understanding of the analyzer's Theory of Operation (see Section **Error! Reference source not found.**).

The acceptable ranges for these test functions are listed in the "Nominal Range" column of the analyzer *Final Test and Validation Data Sheet* (M300E, P/N 04307 and M300EM, P/N 04311) shipped with the instrument. Values outside these acceptable ranges indicate a failure of one or more of the analyzer's subsystems. Functions whose values are still within the acceptable range but have significantly changed from the measurement recorded on the factory data sheet may also indicate a failure.

NOTE:
A worksheet has been provided in Appendix C to assist in recording the value of these test functions. This worksheet also includes expected values for the various test functions.

The following table contains some of the more common causes for these values to be out of range.

Table 13-2: Test Functions - Indicated Failures

TEST FUNCTIONS (As Displayed)	INDICATED FAILURE(S)
TIME	Time of day clock is too fast or slow. To adjust, see Section 6.5.4. Battery in clock chip on CPU board may be dead.
RANGE	Incorrectly configured measurement range(s) could cause response problems with a Data logger or chart recorder attached to one of the analog output. If the Range selected is too small, the recording device will over range. If the Range is too big, the device will show minimal or no apparent change in readings.
STABIL	Indicates noise level of instrument or CO concentration of sample gas (see Section 13.4.2 for causes).
CO MEAS & CO REF	If the value displayed is too high the IR Source has become brighter. Adjust the variable gain potentiometer on the sync/demod board (see Section 13.5.6.1). If the value displayed is too low or constantly changing and the **CO REF** is OK: • Failed multiplexer on the mother board • Failed sync/demod board • Loose connector or wiring on sync/demod board • If the value displayed is too low or constantly changing and the CO REF is bad: • GFC Wheel stopped or rotation is too slow • Failed sync/demod board IR source • Failed IR source • Failed relay board • Failed I^2C bus • Failed IR photo-detector
MR Ratio	When the analyzer is sampling zero air and the ratio is too low: • The reference cell of the GFC Wheel is contaminated or leaking. • The alignment between the GFC Wheel and the segment sensor, the M/R sensor or both is incorrect. • Failed sync/demod board When the analyzer is sampling zero air and the ratio is too high: • Zero air is contaminated • Failed IR photo-detector
PRES	See Table 13-1 for **SAMPLE PRES WARN.**
SAMPLE FL	Check for gas flow problems (see Section 13.2).
SAMP TEMP	SAMPLE TEMP should be close to BENCH TEMP. Temperatures outside of the specified range or oscillating temperatures are cause for concern.
BENCH TEMP	Bench temp control improves instrument noise, stability and drift. Temperatures outside of the specified range or oscillating temperatures are cause for concern. Table 13-1 for BENCH TEMP WARNING.
WHEEL TEMP	Wheel temp control improves instrument noise, stability and drift. Outside of set point or oscillating temperatures are causes for concern. See Table 13-1 for WHEEL TEMP WARNING.
BOX TEMP	If the box temperature is out of range, check fan in the power supply module. Areas to the side and rear of instrument should allow adequate ventilation. See Table 13-1 for BOX TEMP WARNING.

Table 13-2: Test Functions - Indicated Failures (cont.)

TEST FUNCTIONS (As Displayed)	INDICATED FAILURE(S)
PHT DRIVE	If this drive voltage is out of range it may indicate one of several problems: • A poor mechanical connection between the photodetector, its associated mounting hardware and the absorption cell housing; • An electronic failure of the IR Photo-Detector's built-in cooling circuitry, or; • A temperature problem inside the analyzer chassis. In this case other temperature warnings would also be active such as BENCH TEMP WARNING or BOX TEMP WARNING.
SLOPE	Values outside range indicate Contamination of the zero air or span gas supply Instrument is Miscalibrated Blocked gas flow Contaminated or leaking GFC Wheel (either chamber) Faulty IR photo-detector Faulty sample faulty IR photo-detector pressure sensor (P1) or circuitry Invalid M/R ratio (see above) Bad/incorrect span gas concentration due.
OFFSET	Values outside range indicate Contamination of the zero air supply Contaminated or leaking GFC Wheel (either chamber) Faulty IR photo-detector

13.1.3. DIAG → SIGNAL I/O: USING THE DIAGNOSTIC SIGNAL I/O FUNCTION

The signal I/O diagnostic mode allows access to the digital and analog I/O in the analyzer. Some of the digital signals can be controlled through the keyboard. These signals, combined with a thorough understanding of the instruments Theory of Operation (found in Section **Error! Reference source not found.**), are useful for troubleshooting in three ways:

- The technician can view the raw, unprocessed signal level of the analyzer's critical inputs and outputs.
- Many of the components and functions that are normally under algorithmic control of the CPU can be manually exercised.
- The technician can directly control the signal level Analog and Digital Output signals.

This allows the technician to observe systematically the effect of directly controlling these signals on the operation of the analyzer. The following flowchart shows an example of how to use the Signal I/O menu to view the raw voltage of an input signal or to control the state of an output voltage or control signal.

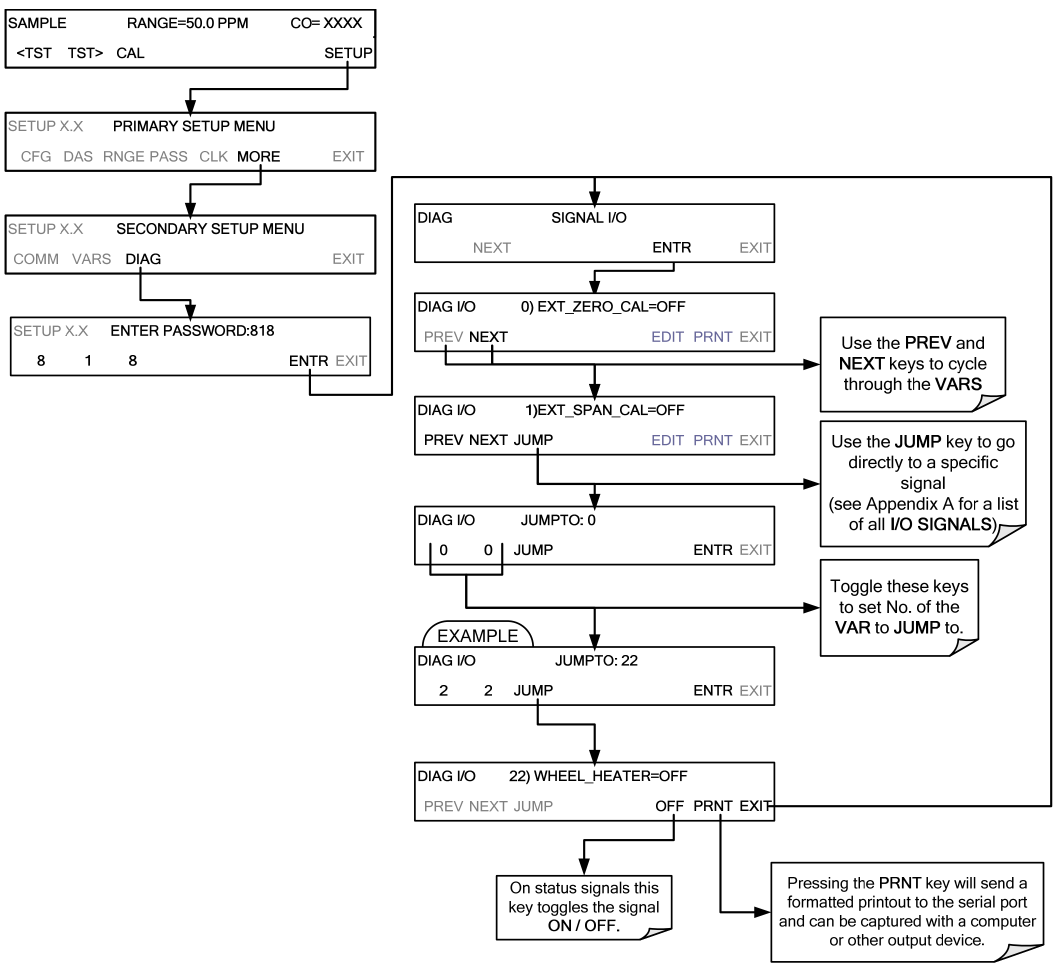


Figure 13-2: Example of Signal I/O Function

> **NOTE**
> **Any I/O signals changed while in the signal I/O menu will remain in effect ONLY until signal I/O menu is exited. The Analyzer regains control of these signals upon exit.**

See Appendix A-4 for a complete list of the parameters available for review under this menu

13.1.4. INTERNAL ELECTRONIC STATUS LED'S

Several LED's are located inside the instrument to assist in determining if the analyzer's CPU, I^2C bus and relay board, GFC Wheel and the sync/demodulator board are functioning properly.

13.1.4.1. CPU Status Indicator

DS5, a red LED, that is located on upper portion of the motherboard, just to the right of the CPU board, flashes when the CPU is running the main program loop. After power-up, approximately 30 to 60 seconds, DS5 should flash on and off. If characters are written to the front panel display but DS5 does not flash then the program files have become corrupted. If after 30 – 60 seconds neither the DS5 is flashing or no characters have been written to the front panel display then the CPU is bad and must be replaced.

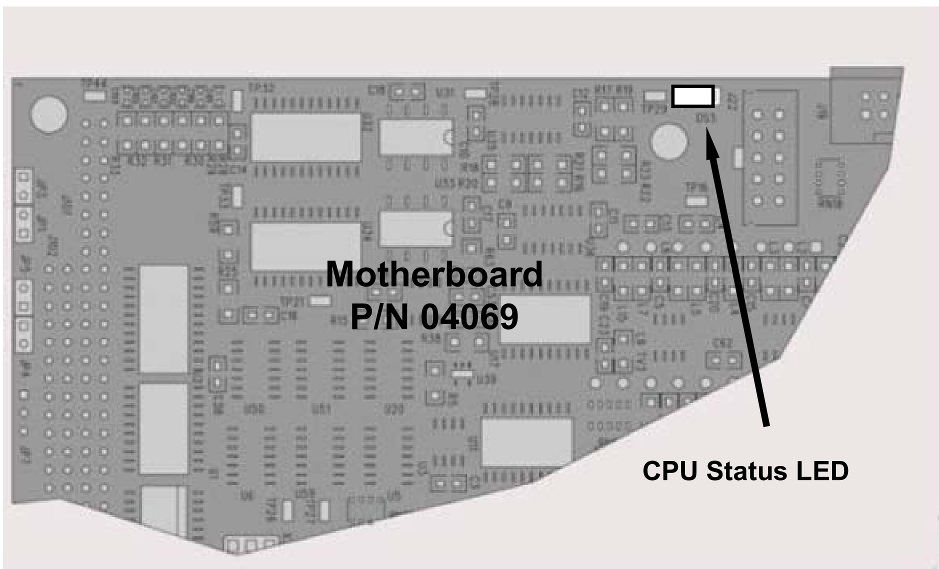


Figure 13-3: CPU Status Indicator

13.1.4.2. **Sync Demodulator Status LED's**

Two LED's located on the Sync/Demod Board and are there to make it obvious that the GFC Wheel is spinning and the synchronization signals are present:

Table 13-3: Sync/Demod Board Status Failure Indications

LED	FUNCTION	FAULT STATUS	INDICATED FAILURE(S)
D1	**M/R Sensor Status** **(Flashes slowly)**	**LED is stuck ON or OFF**	GFC Wheel is not turning M/R Sensor on Opto-Pickup Board failed Sync/Demod Board failed JP 4 Connector/Wiring faulty Failed/Faulty +5 VDC Power Supply (PS1)
D2	**Segment Sensor Status** **(Flashes quickly)**	**LED is stuck ON or OFF**	GFC Wheel is not turning Segment Sensor on Opto-Pickup Board failed Sync/Demod Board failed JP 4 Connector/Wiring faulty Failed/Faulty +5 VDC Power Supply (PS1)

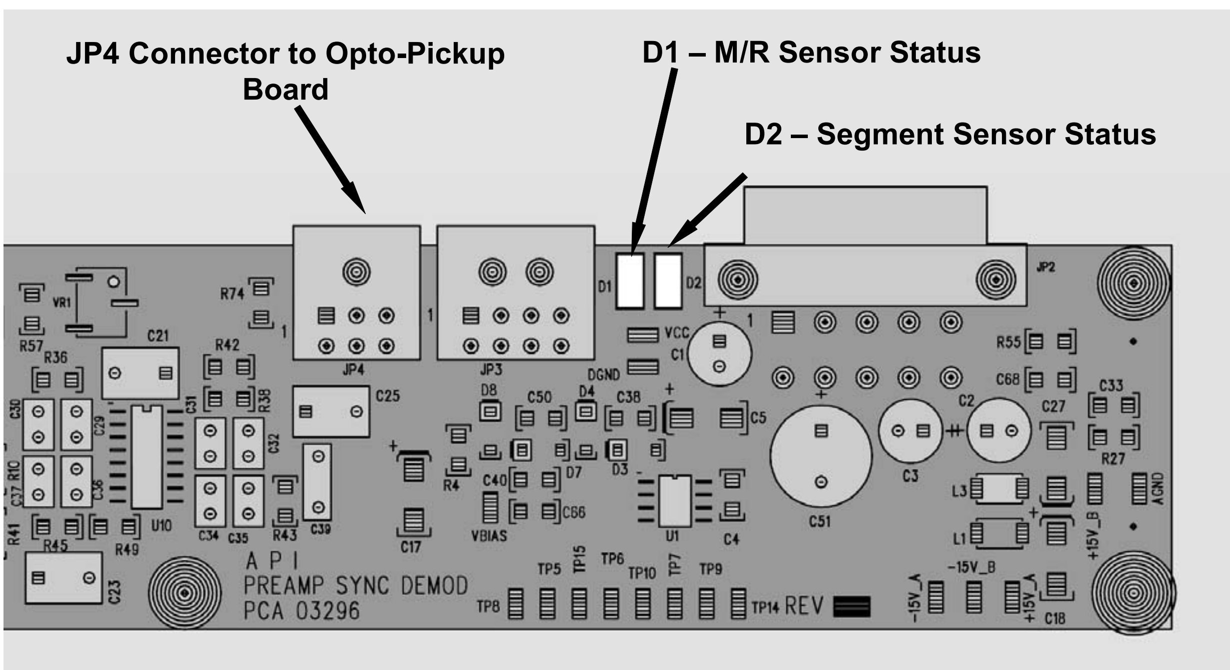


Figure 13-4: Sync/Demod Board Status LED Locations

13.1.4.3. **Relay Board Status LED's**

There are eight LED's located on the Relay Board. The most important of which is D1, which indicates the health of the I^2C bus. If D1 is blinking the other faults following LED's can be used in conjunction with **DIAG** menu signal I/O to identify hardware failures of the relays and switches on the relay (see Section 13.1.3 and Appendix D).

Table 13-4: I^2C Status LED Failure Indications

LED	FUNCTION	FAULT STATUS	INDICATED FAILURE(S)
D1 (Red)	I^2C bus Health (Watch Dog Circuit)	Continuously ON or Continuously OFF	Failed/Halted CPU Faulty Motherboard, Keyboard or Relay Board Faulty Connectors/Wiring between Motherboard, Keyboard or Relay Board Failed/Faulty +5 VDC Power Supply (PS1)

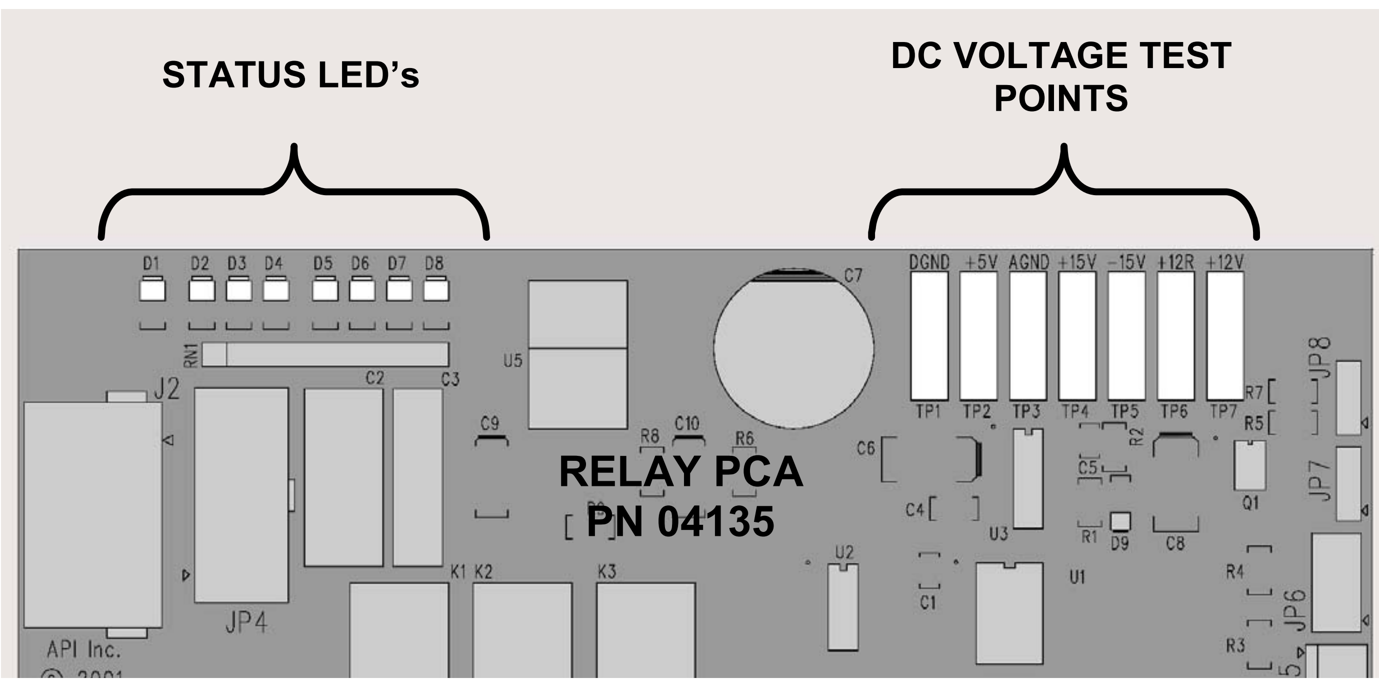


Figure 13-5: Relay Board Status LEDs

Table 13-5: Relay Board Status LED Failure Indications

LED	FUNCTION	SIGNAL I/O PARAMETER		DIAGNOSTIC TECHNIQUE
		ACTIVATED BY	VIEW RESULT	
D2 Yellow	Wheel Heater	**WHEEL_HEATER**	**WHEEL_TEMP**	Voltage displayed should change. If not: Failed Heater Faulty Temperature Sensor Failed AC Relay Faulty Connectors/Wiring
D3 Yellow	Bench Heater	**BENCH_HEATER**	**BENCH_TEMP**	Voltage displayed should change. If not: Failed Heater Faulty Temperature Sensor Failed AC Relay Faulty Connectors/Wiring
D4 Yellow	Spare	**N/A**	**N/A**	N/A
D5 Green	Sample/Cal Gas Valve Option	**CAL_VALVE**	**N/A**	Sample/Cal Valve should audibly change states. If not: Failed Valve Failed Relay Drive IC on Relay Board Failed Relay Board Faulty +12 VDC Supply (PS2) Faulty Connectors/Wiring
D6 Green	Zero/Span Gas Valve Option	**SPAN_VALVE**	**N/A**	Zero/Span Valve should audibly change states. If not: Failed Valve Failed Relay Drive IC on Relay Board Failed Relay Board Faulty +12 VDC Supply (PS2) Faulty Connectors/Wiring
D7 Green	Shutoff Valve Option	**SHUTOFF_VALVE**	**N/A**	Shutoff Valve should audibly change states. If not: Failed Valve Failed Relay Drive IC on Relay Board Failed Relay Board Faulty +12 VDC Supply (PS2) Faulty Connectors/Wiring
D8 Green	IR SOURCE	**IR_SOURCE**	**CO_MEASURE**	Voltage displayed should change. If not: Failed IR Source Faulty +12 VDC Supply (PS2) Failed Relay Board Failed IR Photo-Detector Failed Sync/Demod Board Faulty Connectors/Wiring

13.2. **GAS FLOW PROBLEMS**

When troubleshooting flow problems, it is a good idea to first confirm that the actual flow and not the analyzer's flow sensor and software are in error, or the flow meter is in error. Use an independent flow meter to perform a flow check as described in Section 12.3.4. If this test shows the flow to be correct, check the pressure sensors as described in Section 13.5.6.6.

The M300E/EM has one main gas flow path. With the IZS or zero/span valve option installed, there are several subsidiary paths but none of those are displayed on the front panel or stored by the iDAS.

With the O_2 sensor option installed, third gas flow controlled with a critical flow orifice is added, but this flow is not measured or reported.

In general, flow problems can be divided into three categories:

1. Flow is too high
2. Flow is greater than zero, but is too low, and/or unstable
3. Flow is zero (no flow)

When troubleshooting flow problems, it is crucial to confirm the actual flow rate without relying on the analyzer's flow display. The use of an independent, external flow meter to perform a flow check as described in Section 12.3.4 is essential.

The flow diagrams found in a variety of locations within this manual depicting the M300E/EM in its standard configuration and with options installed can help in trouble-shooting flow problems. For your convenience they are collected here.

13.2.1. **M300E/EM INTERNAL GAS FLOW DIAGRAMS**

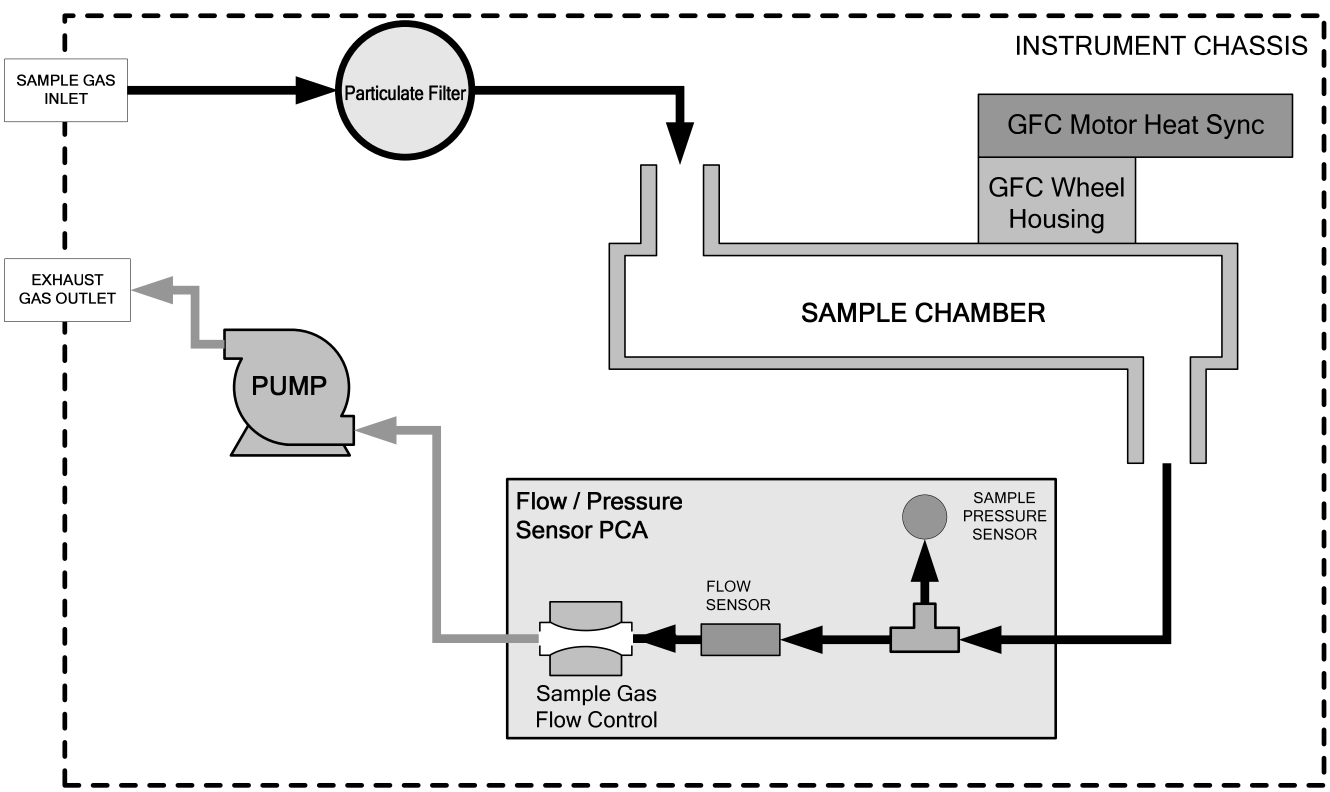


Figure 13-6: M300E/EM – Basic Internal Gas Flow

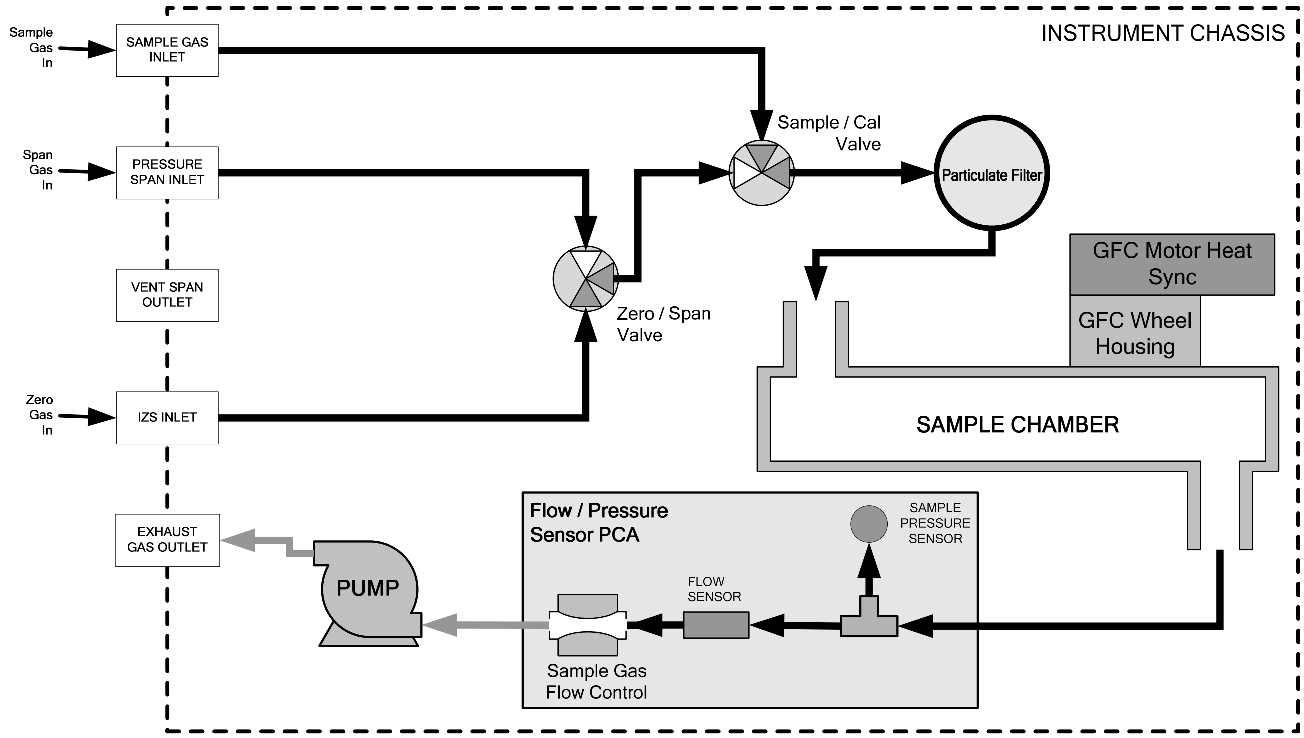


Figure 13-7: Internal Pneumatic Flow OPT 50A – Zero/Span Valves (OPT 50A & 50B)

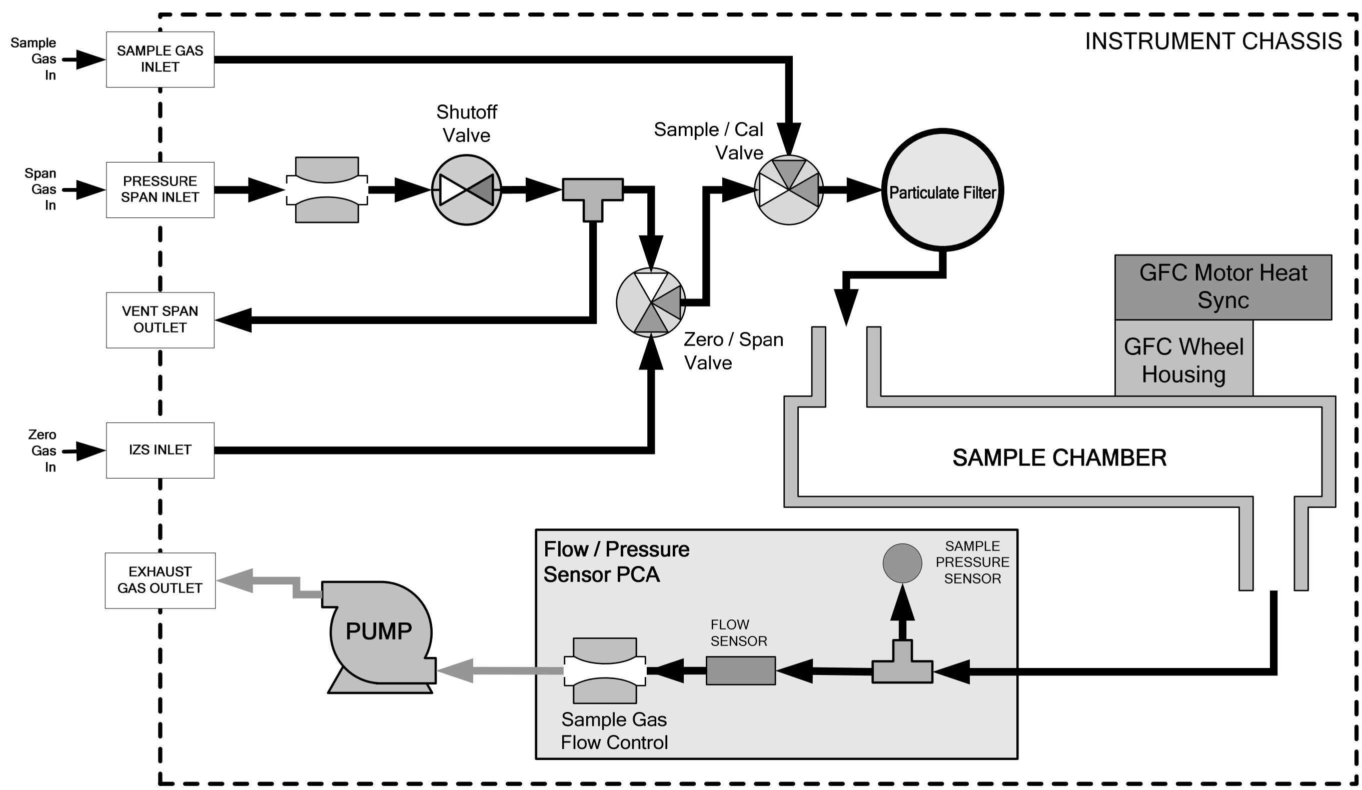


Figure 13-8: Internal Pneumatic Flow OPT 50B – Zero/Span/Shutoff Valves

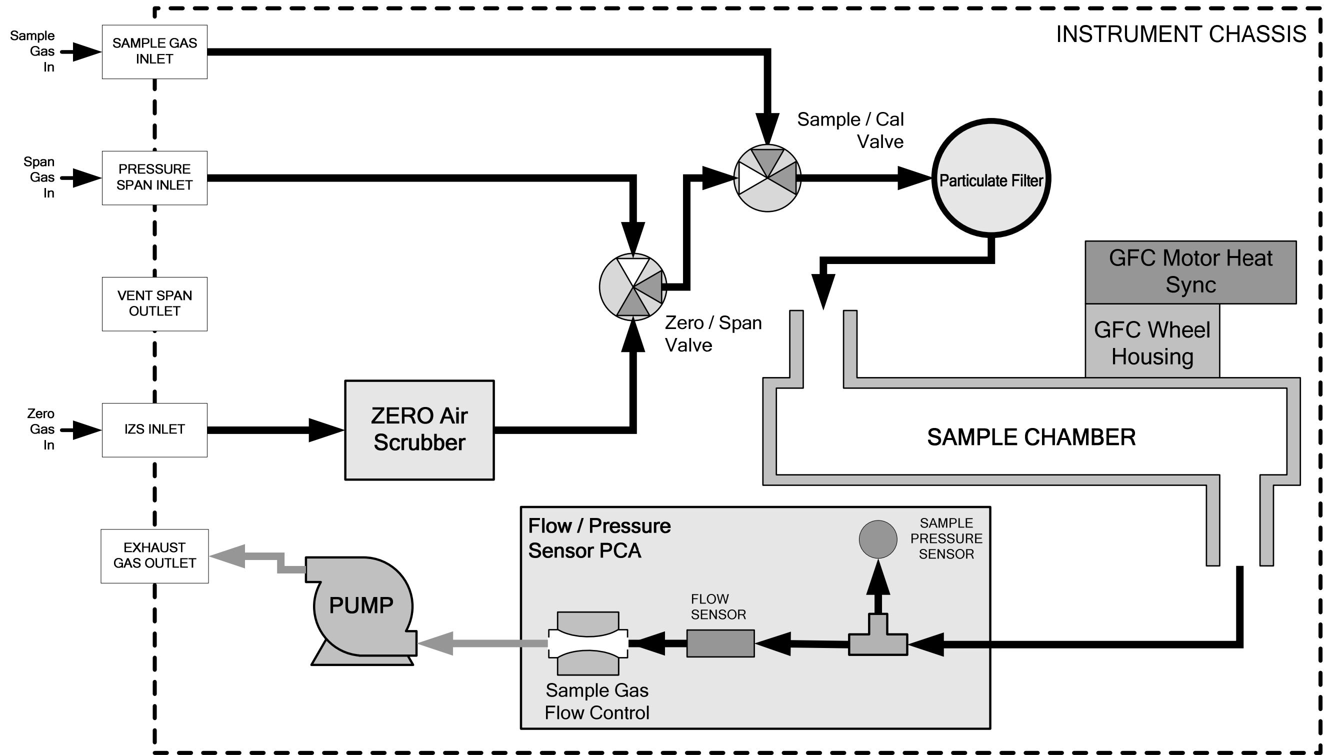


Figure 13-9: Internal Pneumatic Flow OPT 51B – Zero/Span Valves with Internal Zero Air Scrubber

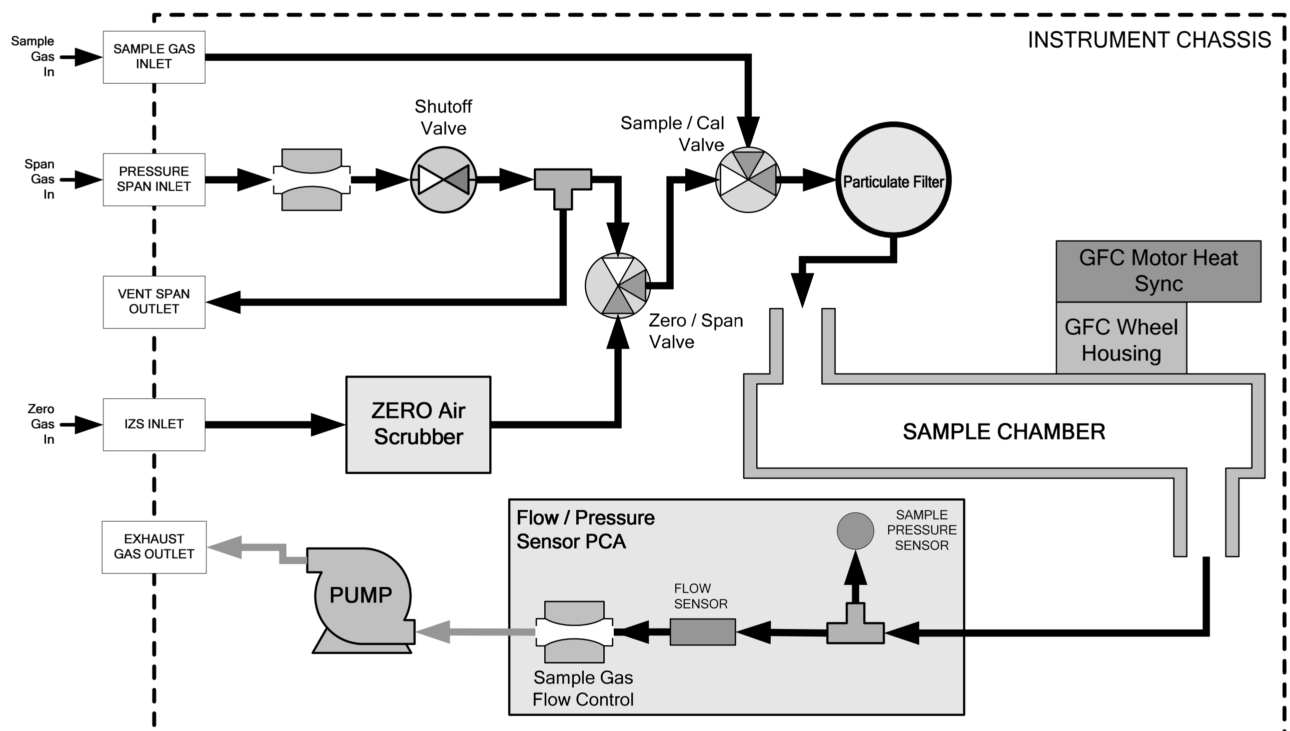


Figure 13-10: Internal Pneumatic Flow OPT 51C – Zero/Span/Shutoff w/ Internal Zero Air Scrubber

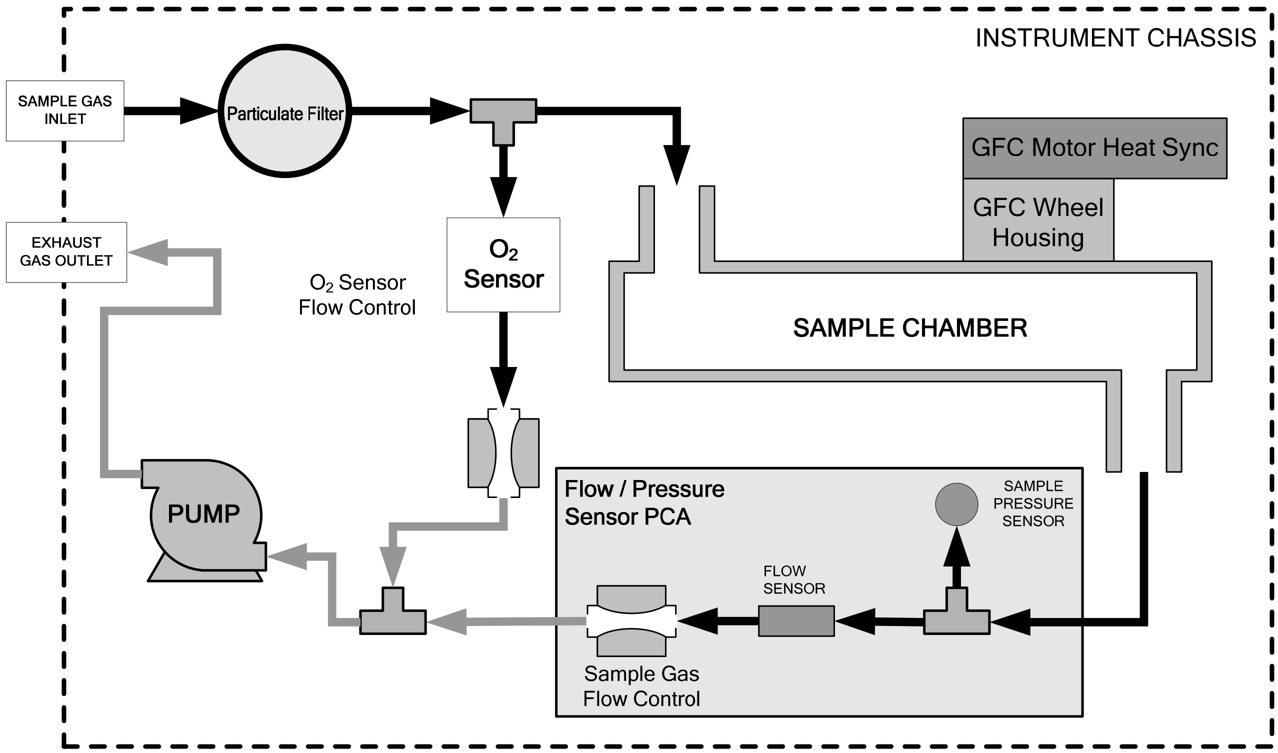


Figure 13-11: M300E/EM – Internal Pneumatics with O_2 Sensor Option 65

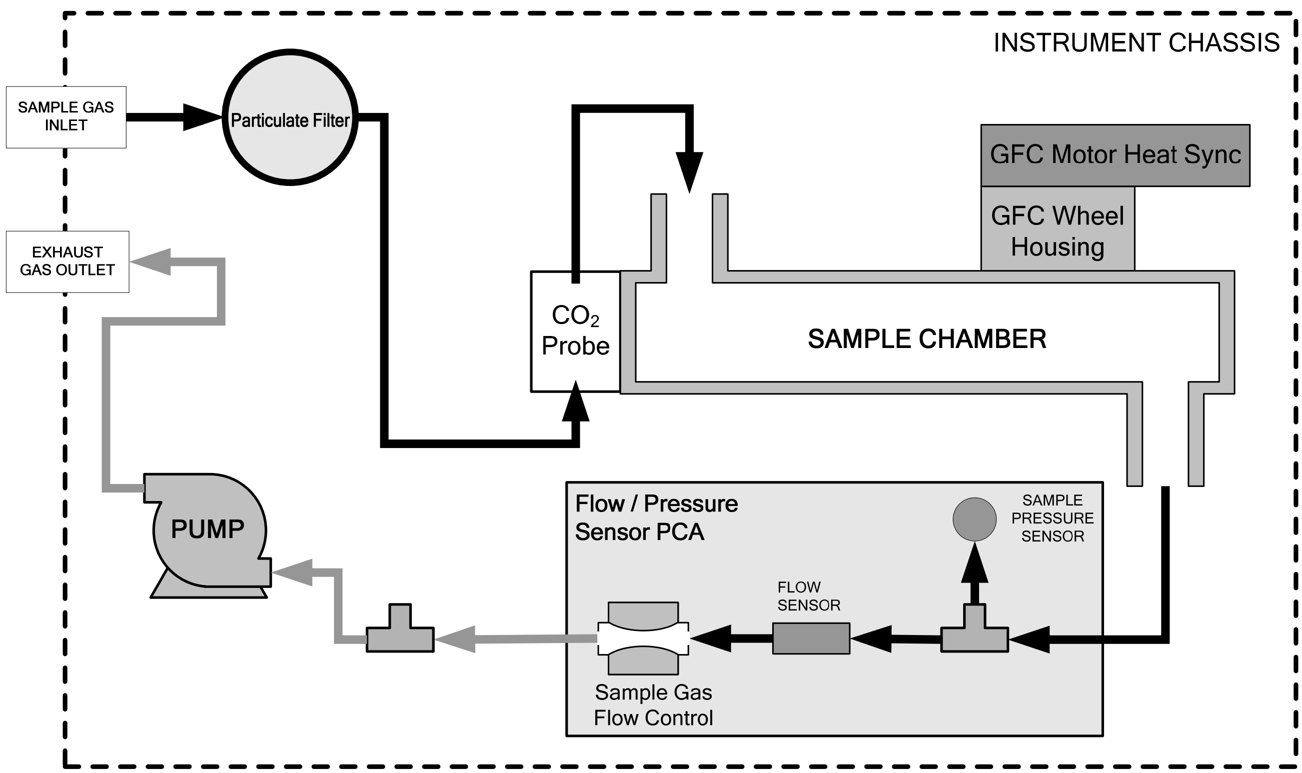


Figure 13-12: M300E/EM – Internal Pneumatics with CO_2 Sensor Option 66

13.2.2. TYPICAL SAMPLE GAS FLOW PROBLEMS

13.2.2.1. Flow is Zero

The unit displays a SAMPLE FLOW warning message on the front panel display or the SAMPLE FLOW test function reports a zero or very low flow rate.

Confirm that the sample pump is operating (turning). If not, use an AC voltmeter to make sure that power is being supplied to the pump if no power is present at the electrical leads of the pump.

1. If AC power is being supplied to the pump, but it is not turning, replace the pump.
2. If the pump is operating but the unit reports no gas flow, perform a flow check as described in Section 12.3.4.
3. If no independent flow meter is available:
   - Disconnect the gas lines from both the sample inlet and the exhaust outlet on the rear panel of the instrument.
   - Make sure that the unit is in basic SAMPLE Mode.
   - Place a finger over an Exhaust outlet on the rear panel of the instrument.
   - If gas is flowing through the analyzer, you will feel pulses of air being expelled from the Exhaust outlet.
4. If gas flows through the instrument when it is disconnected from its sources of zero air, span gas or sample gas, the flow problem is most likely not internal to the analyzer. Check to make sure that:
   - All calibrators/generators are turned on and working correctly.
   - Gas bottles are not empty or low.
   - Valves, regulators and gas lines are not clogged or dirty.

13.2.2.2. Low Flow

1. Check if the pump diaphragm is in good condition. If not, rebuild the pump (see Section 12.3.2). Check the Spare Parts List for information on pump rebuild kits.
2. Check for leaks as described in Section 12.3.3. Repair the leaking fitting, line or valve and re-check.
3. Check for the sample filter and the orifice filter for dirt. Replace filters (see 12.3.1).
4. Check for partially plugged pneumatic lines, or valves. Clean or replace them.
5. Check for plugged or dirty critical flow orifices. Replace them.
6. If an IZS option is installed in the instrument, press CALZ and CALS. If the flow increases then suspect a bad sample/cal valve.

13.2.2.3. High Flow

The most common cause of high flow is a leak in the sample flow control assembly or between there and the pump. If no leaks or loose connections are found in the fittings or the gas line between the orifice and the pump, replace the critical flow orifice(s) inside the sample flow control assembly.

13.2.2.4. **Displayed Flow = “Warnings”**

This warning means that there is inadequate gas flow. There are four conditions that might cause this:

1. A leak upstream or downstream of the flow sensor
2. A flow obstruction upstream or downstream of the flow sensor
3. Bad Flow Sensor Board
4. Bad pump

To determine which case is causing the flow problem, view the sample pressure and sample flow functions on the front panel. If the sample pressure is reading abnormally low, then the cause is likely a flow obstruction upstream of the flow sensor. First, check the sample filter and make sure it is not plugged and then systematically check all the other components upstream of the orifice to ensure that they are not obstructed.

If the sample pressure is reading normal but the sample flow is reading low then it is likely that the pump diaphragm is worn or there is an obstruction downstream of the flow sensor.

13.2.2.5. **Actual Flow Does Not Match Displayed Flow**

If the actual flow measured does not match the displayed flow, but is within the limits of 720-880 cm^3/min, adjust the calibration of the flow measurement as described in Section 12.3.4.

13.2.2.6. **Sample Pump**

The sample pump should start immediately after the front panel power switch is turned ON. With the Sample Inlet plugged, the test function PRES should read about 10 in-Hg for a pump that is in good condition. The pump needs rebuilding if the reading is above 10 in-Hg. If the test function SAMP FL is greater than 10 cm^3/min there is a leak in the pneumatic lines.

13.3. **CALIBRATION PROBLEMS**

13.3.1. **MISCALIBRATED**

There are several symptoms that can be caused by the analyzer being miscalibrated. This condition is indicated by out of range Slopes and Offsets as displayed through the test functions and is frequently caused by the following:

1. Bad span gas. This can cause a large error in the slope and a small error in the offset. Delivered from the factory, the M300E Analyzer’s slope is within ±15% of nominal. Bad span gas will cause the analyzer to be calibrated to the wrong value. If in doubt have the span gas checked by an independent lab.
2. Contaminated zero gas. Excess H_2O can cause a positive or negative offset and will indirectly affect the slope.
3. Dilution calibrator not set up correctly or is malfunctioning. This will also cause the slope, but not the zero, to be incorrect. Again the analyzer is being calibrated to the wrong value.
4. Too many analyzers on the manifold. This can cause either a slope or offset error because ambient gas with its pollutants will dilute the zero or span gas.

13.3.2. NON-REPEATABLE ZERO AND SPAN

As stated earlier, leaks both in the M300E/EM and in the external system are a common source of unstable and non-repeatable readings.

1. Check for leaks in the pneumatic systems as described in Section 12.3.3. Don't forget to consider pneumatic components in the gas delivery system outside the M300E/EM such as:
   - A change in zero air source such as ambient air leaking into zero air line, or;
   - A change in the span gas concentration due to zero air or ambient air leaking into the span gas line.
2. Once the instrument passes a leak check, perform a flow check (see Section 12.3.4) to make sure adequate sample is being delivered to the sensor assembly.
3. A failing IR photo-detector may be at fault. Check the **CO MEAS** and **CO REF** test functions via the front panel display to make sure the signal levels are in the normal range (See Appendix A) and are quiet.
4. Confirm the sample pressure, wheel temperature, bench temperature, and sample flow readings are correct and have steady readings.
5. Disconnect the exhaust line from the optical bench near the rear of the instrument and plug this line into the SAMPLE inlet creating a pneumatic loop. The CO concentration (either zero or span) now must be constant. If readings become quiet, the problem is in the external pneumatics supplies for sample gas, span gas or zero air.
6. If pressurized span gas is being used with a zero/span valve option, make sure that the venting is adequate.

13.3.3. INABILITY TO SPAN – NO SPAN KEY

1. Confirm that the carbon monoxide span gas source is accurate; this can be done by switching between two span-gas tanks. If the CO concentration is different, there is a problem with one of the tanks.
2. Check for leaks in the pneumatic systems as described in Section 12.3.3.
3. Make sure that the expected span gas concentration entered into the instrument during calibration is the correct span gas concentration and not too different from expected span value. This can be viewed via the CONC submenu of the Sample Displays.
4. Check to make sure that there is no ambient air or zero air leaking into span gas line.

13.3.4. INABILITY TO ZERO – NO ZERO KEY

1. Confirm that there is a good source of zero air. Dilute a tank of span gas with the same amount of zero air from two different sources. If the CO Concentration of the two measurements is different, there is a problem with one of the sources of zero air.
2. Check for leaks in the pneumatic systems as described in 12.3.3.
3. If the analyzer has had zero/span valve options, the CO scrubber may need maintenance.
4. Check to make sure that there is no ambient air leaking into zero air line.

13.4. OTHER PERFORMANCE PROBLEMS

Dynamic problems (i.e. problems which only manifest themselves when the analyzer is monitoring sample gas) can be the most difficult and time consuming to isolate and resolve. The following provides an itemized list of the most common dynamic problems with recommended troubleshooting checks and corrective actions.

13.4.1. TEMPERATURE PROBLEMS

Individual control loops are used to maintain the set point of the absorption bench, filter wheel and IR photo-detector temperatures. If any of these temperatures are out of range or are poorly controlled, the M300E/EM will perform poorly.

13.4.1.1. Box or Sample Temperature

BOX TEMPERATURE

The box temperature sensor is mounted to the motherboard and cannot be disconnected to check its resistance. Rather check the **BOX TEMP** signal using the SIGNAL I/O function under the **DIAG** Menu (See Section 7.3). This parameter will vary with ambient temperature, but at ~30°C (6-7° above room temperature) the signal should be ~1450 mV.

SAMPLE TEMPERATURE

The Sample Temperature should closely track the bench temperature. If it does not, locate the sensor, which is located at the midpoint of the optical bench in a brass fitting. Unplug the connector labeled “Sample”, and measure the resistance of the thermistor; at room temperature (25°C) it should be ~30K Ohms, at operating temperature, 48°C, it should be ~ 12K Ohms

13.4.1.2. Bench Temperature

There are three possible failures that could cause the Bench temperature to be incorrect.

1. The heater mounted to the bottom of the Absorption bench is electrically shorted or open.
   - Check the resistance of the two heater elements by measuring between pin 2 and 4 (~76 Ohms), and pin 3 and 4 (~330 Ohms), of the white five-pin connector just below the sample temperature sensor on the Bench (pin 1 is the pointed end).
2. Assuming that the I^2C bus is working and that there is no other failure with the relay board, the solid-state relay (K2) on the relay board may have failed.
   - Using the BENCH_HEATER parameter under the signal I/O function, as described above, turn on and off K2 (D3 on the relay board should illuminate as the heater is turned on).
   - Check the AC voltage present between pin 2 and 4, for a 100 or 115 VAC model, and pins 3 and 4, for a 220-240 VAC model.

CAUTION
ELECTRICAL SHOCK HAZARD
Hazardous Voltages are present during this test

3. If the relay has failed there should be no change in the voltage across pins 2 and 4 or 3 and 4. Note: K2 is in a socket for easy replacement.
4. If K2 checks out OK, the thermistor temperature sensor located on the optical bench near the front of the instrument could be at fault.

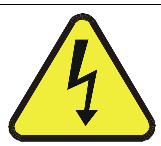
- Unplug the connector labeled “Bench”, and measure the resistance of the thermistor.

- At room temperature it should have approximately 30K Ohms resistance; near the 48°C set point it should have ~12K ohms.

13.4.1.3. **GFC Wheel Temperature**

Like the bench heater above there are three possible causes for the GFC Wheel temperature to have failed.

1. The wheel heater has failed.
   - Check the resistance between pins 1 and 4 on the white five-pin connector just below the sample temperature sensor on the bench (pin 1 is the pointed end).
   - It should be approximately 275 ohms.
2. Assuming that the I^2C bus is working and that there is no other failure with the relay board; the solid-state relay (K1) on the relay board may have failed.
   - Using the **WHEEL_HEATER** parameter under the signal I/O function, as described above, turn on and off K1 (D2 on the relay board should illuminate as the heater is turned on).
   - Check the AC voltage present between pin 1 and 4.



CAUTION

ELECTRICAL SHOCK HAZARD

Hazardous Voltages are present during this test

3. If the relay has failed there should be no change in the voltage across pins 1 and 4.
   - K1 is socketed for easy replacement.
4. If K1 checks out OK, the thermistor temperature sensor located at the front of the filter wheel assembly may have failed.
5. Unplug the connector labeled "Wheel", and measure the resistance of the thermistor. The resistance near the 68°C set point is ~5.7k ohms.

13.4.1.4. **IR Photo-Detector TEC Temperature**

If the PHT DRIVE test parameter described in Table 12-3 is out of range there are four possible causes of failure.

1. The screws retaining the IR photo detector to the absorption bench have become loose.
   - Carefully tighten the screws, hand-tight and note whether, after the analyzer has come up to operating temperature, whether the **PHT DRIVE** voltage has returned to an acceptable level.
2. The two large transistor-type devices mounted to the side of the Absorption Bench have come loose from the bench.
   - Tighten the retaining screws and note whether there is an improvement in the **PHT DRIVE** voltage.
3. The photo-detector has failed. Contact the factory for instructions.
4. The sync demodulator circuit board has failed. Contact the factor for instructions.

13.4.2. EXCESSIVE NOISE

Noise is continuously monitored in the **TEST** functions as the **STABIL** reading and only becomes meaningful after sampling a constant gas concentration for at least 10 minutes. Compare the current **STABIL** reading with that recorded at the time of manufacture (included in the M300E/EM *Final Test and Validation Data Sheet*,P/N 04271 shipped with the unit from Teledyne API).

1. The most common cause of excessive noise is leaks. Leak check and flow check the instrument described in Section 12.3.3 and 12.3.4.
2. Detector failure – caused by failure of the hermetic seal or over-temperature due to poor heat sinking of the detector can to the optical bench.
   - In addition to increased noise due to poor signal-to-noise ratio, another indicator of detector failure is a drop in the signal levels of the **CO MEASURE** signal and **CO REFERENCE** signal.
3. Sync/Demod Board failure. There are many delicate, high impedance parts on this board. Check the **CO MEAS** and **CO REF** Test Functions via the Front Panel Display.
4. The detector cooler control circuit can fail for reasons similar to the detector itself failing. Symptoms would be a change in **MR RATIO** Test Function when zero air is being sampled.
5. Also check the SIGNAL I/O parameter **PHT DRIVE**.
   - After warm-up, and at 25^{o}C ambient, if **PHT DRIVE** < 4800 mV, the cooler is working properly.
   - If **PHT DRIVE** is > 4800 mV there is a malfunction.
6. The +5 and $\pm$15 VDC voltages in the M300E/EM are provided by switching power supplies.
   - Switch mode supplies create DC outputs by switching the input AC waveform at high frequencies.
   - As the components in the switcher age and degrade, the main problem observed is increased noise on the DC outputs.
   - If a noisy switcher power supply is suspected, attach an oscilloscope to the DC output test points located on the top right hand edge of the Relay board.
   - Look for short period spikes > 100 mV p-p on the DC output.

13.5. SUBSYSTEM CHECKOUT

The preceding of this manual discussed a variety of methods for identifying possible sources of failures or performance problems within the analyzer. In most cases this included a list of possible causes. This describes how to determine individually determine if a certain component or subsystem is actually the cause of the problem being investigated.

13.5.1. AC MAINS CONFIGURATION

The analyzer is correctly configured for the AC mains voltage in use if:

1. The Sample Pump is running.
2. The GFC Wheel motor is spinning. LED's D1 & D2 (located on the sync/demod PCA) should be flashing.
3. If incorrect power is suspected, check that the correct voltage and frequency is present at the line input on the rear panel.
   - If the unit is set for 230 VAC and is plugged into 115VAC, or 100VAC the sample pump will not start, and the heaters will not come up to temperature.
   - If the unit is set for 115 or 100 VAC and is plugged into a 230 VAC circuit, the circuit breaker built into the ON/OFF Switch on the Front Panel will trip to the OFF position immediately after power is switched on.

13.5.2. DC POWER SUPPLY

If you have determined that the analyzer's AC mains power is working, but the unit is still not operating properly, there may be a problem with one of the instrument's switching power supplies. The supplies can have two faults, namely no DC output, and noisy output.

To assist tracing DC Power Supply problems, the wiring used to connect the various printed circuit assemblies and DC Powered components and the associated test points on the relay board follow a standard color-coding scheme as defined in the following table.

Table 13-6: DC Power Test Point and Wiring Color Codes

NAME	TEST POINT#	TP AND WIRE COLOR
Dgnd	1	Black
+5V	2	Red
Agnd	3	Green
+15V	4	Blue
-15V	5	Yellow
+12R	6	Purple
+12V	7	Orange

A voltmeter should be used to verify that the DC voltages are correct per the values in the table below, and an oscilloscope, in AC mode, with band limiting turned on, can be used to evaluate if the supplies are producing excessive noise (> 100 mV p-p).

Table 13-7: DC Power Supply Acceptable Levels

POWER SUPPLY ASSY	VOLTAGE	CHECK RELAY BOARD TEST POINTS				MIN V	MAX V
		FROM TEST POINT		TO TEST POINT			
		NAME	#	NAME	#		
PS1	+5	Dgnd	1	+5	2	4.8	5.25
PS1	+15	Agnd	3	+15	4	13.5	16V
PS1	-15	Agnd	3	-15V	5	-14V	-16V
PS1	Agnd	Agnd	3	Dgnd	1	-0.05	0.05
PS1	Chassis	Dgnd	1	Chassis	N/A	-0.05	0.05
PS2	+12	+12V Ret	6	+12V	7	11.75	12.5
PS2	Dgnd	+12V Ret	6	Dgnd	1	-0.05	0.05

13.5.3. I^2C BUS

Operation of the I^2C bus can be verified by observing the behavior of DS6 and DS7 on the motherboard and D1 on the relay board in conjunction with the performance of the front panel display. Assuming that the DC power supplies are operating properly and the wiring from the motherboard to the keyboard, and the wiring from the keyboard to the relay board, is intact, the I^2C bus is operating properly if:

- DS6 and DS7 on the motherboard are flashing at least once every 2 seconds and D1 on the relay board is flashing, or;
- D1 is not flashing but pressing a key on the front panel results in a change to the display.

13.5.4. KEYBOARD/DISPLAY INTERFACE

The front panel keyboard, display and Keyboard Display Interface PCA (P/N 03975 or 04258) can be verified by observing the operation of the display when power is applied to the instrument and when a key is pressed on the front panel. Assuming that there are no wiring problems and that the DC power supplies are operating properly:

1. The vacuum fluorescent display is good if on power-up a “-“ character is visible on the upper left hand corner of the display.
2. The CPU Status LED, DS5, is flashing, see Section 13.1.4.1.
3. If there is a “-“ character on the display at power-up and D1 on the relay board is flashing then the keyboard/display interface PCA is bad.
4. If the analyzer starts operation with a normal display but pressing a key on the front panel does not change the display, then there are three possible problems:
   - One or more of the keys is bad,
   - The interrupt signal between the Keyboard Display interface and the motherboard is broken, or
   - The Keyboard Display Interface PCA is bad.

13.5.5. **RELAY BOARD**

The relay board PCA (P/N 04135) can be most easily checked by observing the condition of the its status LED's on the relay board, as described in Section 13.1.4.3, and the associated output when toggled on and off through signal I/O function in the diagnostic menu, see Section 13.1.3.

1. If the front panel display responds to key presses and D1 on the relay board is NOT flashing then either the wiring between the Keyboard and the relay board is bad, or the relay board is bad.
2. If D1 on the relay board is flashing and the status indicator for the output in question (heater power, valve drive, etc.) toggles properly using the signal I/O function, then the associated control device on the relay board is bad.
   - Several of the control devices are in sockets and can be easily replaced.
   - The table below lists the control device associated with a particular function:

Table 13-8: Relay Board Control Devices

FUNCTION	CONTROL DEVICE	IN SOCKET
Wheel Heater	K1	Yes
Bench Heater	K2	Yes
Spare AC Control	K3	Yes
IZS Valves	U4	Yes
IR Source Drive	U5	No

The IR source drive output can be verified by measuring the voltage at J16 with the IR source disconnected. It should be 11.5± 0.5 VDC.

13.5.6. **SENSOR ASSEMBLY**

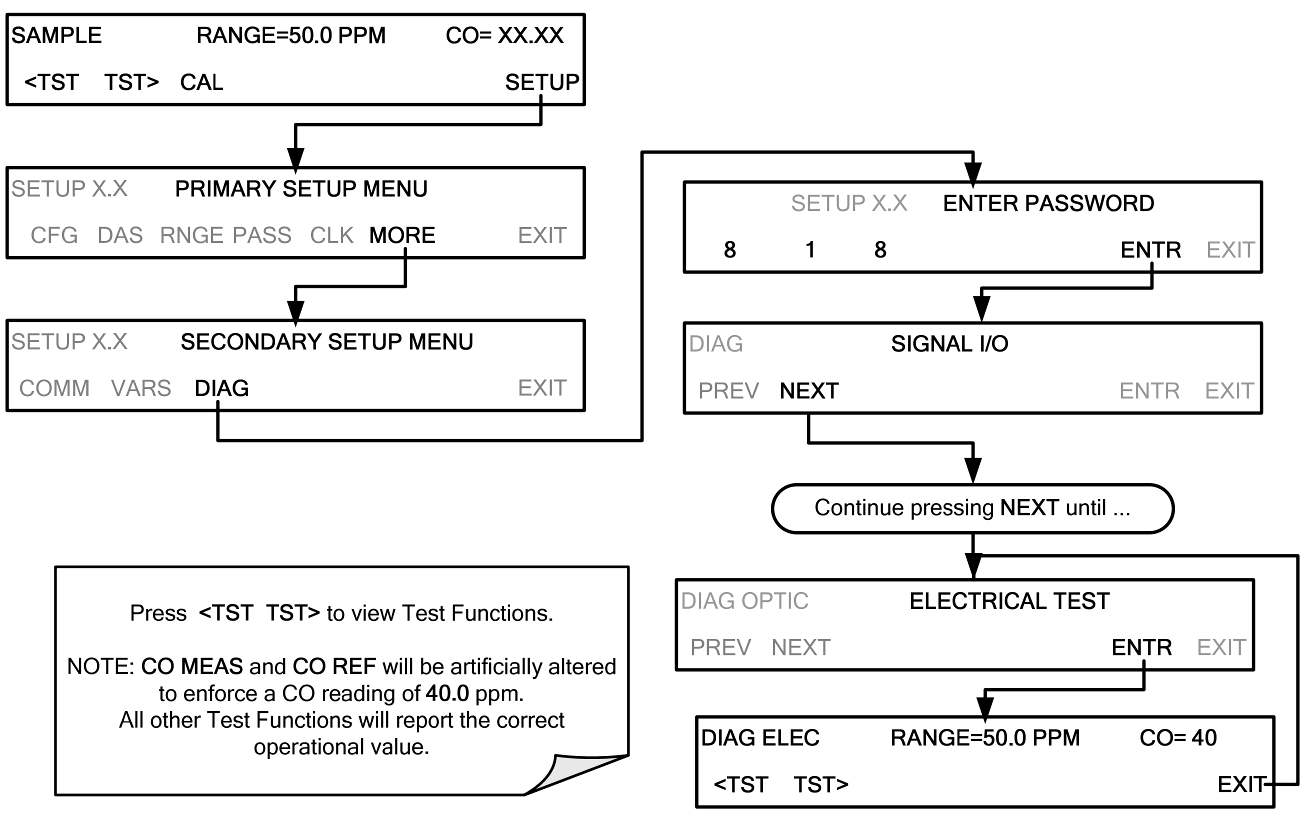
13.5.6.1. **Sync/Demodulator Assembly**

To verify that the Sync/Demodulator Assembly is working, follow the procedure below:

1. Verify that D1 and D2 are flashing.
   - If not check the opto pickup assembly, Section 13.5.6.3 and the GFC Wheel drive, Section 13.5.6.4.
   - If the wheel drive and opto pickup are working properly then verify that there is 2.4 ±0.1 VAC and 2.5 ±0.15 VDC between digital ground and TP 5 on the sync/demod board. If not then check the wiring between the sync/demod and opto pickup assembly (see interconnect drawing, P/N 04216). If good then the sync/demod board is bad.
2. Verify that the IR source is operating, Section 13.5.6.5.
3. With the analyzer connected to zero air, measure between TP11 (measure) and analog ground, and TP12 (reference) and analog ground.
   - If they are similar to values recorded on the factory data sheet then there is likely a problem with the wiring or the A/D converter.
   - If they are not then either the sync demodulator board or the IR-photodetector are bad. See Section 13.4.1.4 for problems with the IR-photodetector TEC drive.

13.5.6.2. **Electrical Test**

The electric test function substitutes simulated signals for **CO MEAS** and **CO REF**, generated by circuitry on the sync/demod board, for the output of the IR photo-detector. While in this mode the user can also view the same test functions viewable from the main **SAMPLE** display. When the test is running, the concentration reported on the front panel display should be 40.0 ppm. (See Section 9.6.4 to calibrate Electrical Test).



13.5.6.3. **Opto Pickup Assembly**

Operation of the opto pickup PCA (P/N 04088) can be verified with a voltmeter. Measure the AC and DC voltage between digital ground on the relay board, or keyboard and TP2 and TP4 on the sync pickup PCA. For a working board, with the GFC motor spinning, they should read 2.4 ±0.1 VAC and 2.5 ±0.15 VDC.

Further confirmation that the pickups and motor are operating properly can be obtained by measuring the frequency at TP2 and TP4 using a frequency counter, a digital voltmeter with a frequency counter, or an oscilloscope per Table 13-9.

Table 13-9: Opto Pickup Board Nominal Output Frequencies

	Nominal Measured Frequency	
AC Mains Freq.	**TP2**	**TP4**
50 Hz	25	300
60 Hz	30	360

13.5.6.4. **GFC Wheel Drive**

If the D1 and D2 on the sync demodulator board are not flashing then:

1. Check for power to the motor by measuring between pins 1 and 3 on the connector feeding the motor.
   - For instruments configured for 120 or 220-240VAC there should be approximately 88 VAC for instruments configured for 100VAC, it should be the voltage of the AC mains, approximately 100VAC.
2. Verify that the frequency select jumper, JP4, is properly set on the relay board.
   - For 50 Hz operation it should be installed.
   - For 60 Hz operation may either be missing or installed in a vertical orientation.
3. If there is power to the motor and the frequency select jumper is properly set then the motor is likely bad.
   - See Section 13.6.2 for instructions on removing and replacing the GFC assembly that the motor is bolted to.

13.5.6.5. **IR Source**

The IR source can be checked using the following procedure:

1. Disconnect the source and check its resistance when cold.
   - When new, the source should have a cold resistance of more than 1.5 Ohms but less than 3.5 Ohms.
   - If not, then the source is bad.
2. With the source disconnected, energize the analyzer and wait for it to start operating.
   - Measure the drive Voltage between pins 1 and 2 on the jack that the source is normally connected to; it should be 11.5 ± 0.25 VDC.
   - If not, then there is a problem with either the wiring, the relay board, or the +12V power supply.
3. If the drive voltage is correct in step 2, then remove the source from the heat sink assembly (2 screws on top) and connect to its mating connector.
   - Observe the light being emitted from the source.
   - It should be centered at the bottom of the U-shaped element.
   - If there is either no emission or a badly centered emission then the source is bad.

13.5.6.6. **Pressure/Flow Sensor Assembly**

The pressure/flow sensor PCA, located on the top of the absorption bench, can be checked with a voltmeter using the following procedure which, assumes that the wiring is intact, and that the motherboard and the power supplies are operating properly:

1. For Pressure related problems:
   - Measure the voltage across C1 it should be 5 ± 0.25 VDC.
     - If not then the board is bad.
   - Measure the voltage across TP4 and TP1.
     - With the sample pump disabled it should be 4500 mV ±250 mV.
     - With the pump energized it should be approximately 200 mV less. If not, then S1, the pressure transducer is bad, the board is bad, or there is a pneumatic failure preventing the pressure transducer from sensing the absorption cell pressure properly.
2. For flow related problems:
   - Measure the voltage across TP2 and TP1 it should be 10 ±0.25 VDC.
     - If not then the board is bad.
     - Measure the voltage across TP3 and TP1.
       With proper flow (800 sccm at the sample inlet) this should be approximately 4.5V (this voltage will vary with altitude).
     - With flow stopped (sample inlet blocked) the voltage should be approximately 1V.
     - If the voltage is incorrect, the flow sensor is bad, the board is bad or there is a leak upstream of the sensor.

13.5.7. MOTHERBOARD

13.5.7.1. A/D Functions

The simplest method to check the operation of the A-to-D converter on the motherboard is to use the Signal I/O function under the **DIAG** menu to check the two A/D reference voltages and input signals that can be easily measured with a voltmeter.

3. Use the Signal I/O function (see Section 13.1.3 and Appendix A) to view the value of REF_4096_MV and REF_GND.
   - If both are within 3 mV of nominal (4096 and 0), and are stable, ±0.5 mV then the basic A/D is functioning properly. If not then the motherboard is bad.
4. Choose a parameter in the Signal I/O function such as SAMPLE_PRESSURE, SAMPLE_FLOW, CO_MEASURE or CO_REFERENCE.
   - Compare these voltages at their origin (see interconnect drawing, P/N 04215 and interconnect list, P/N 04216) with the voltage displayed through the signal I/O function.
   - If the wiring is intact but there is a large difference between the measured and displayed voltage (±10 mV) then the motherboard is bad.

13.5.7.2. Test Channel / Analog Outputs Voltage

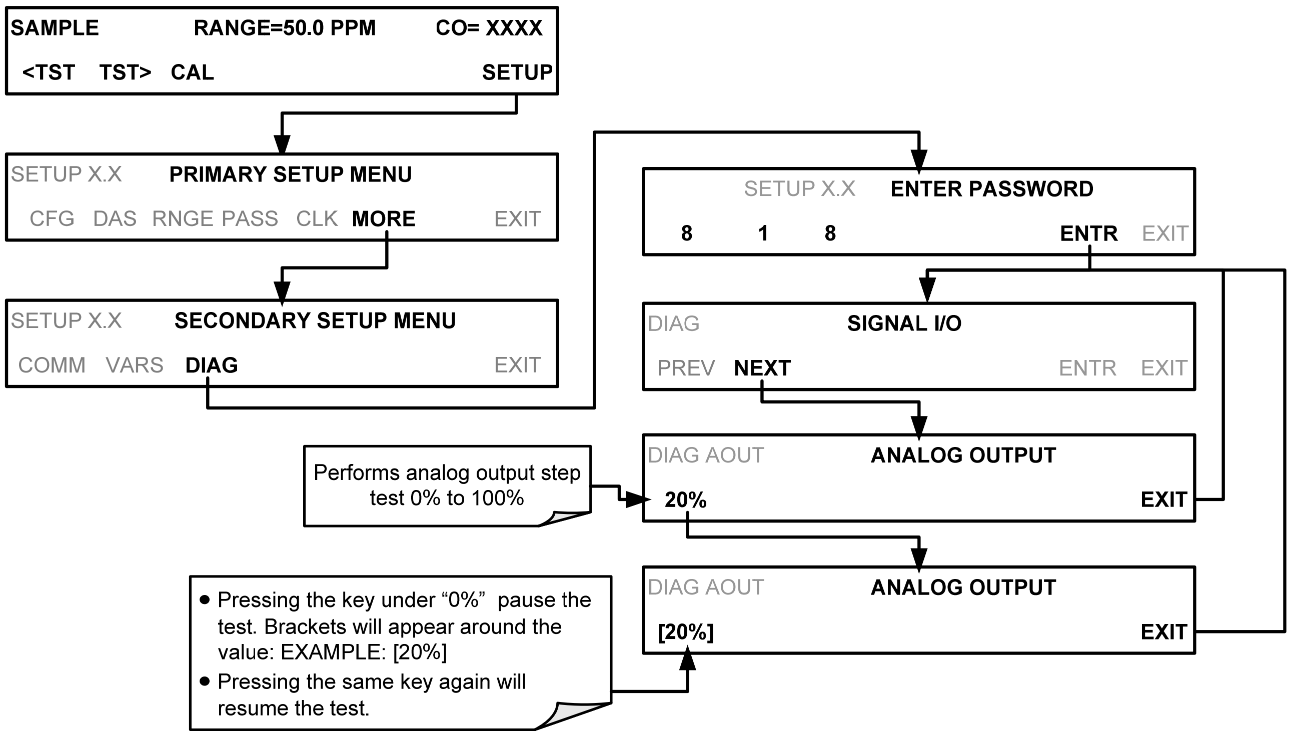
The **ANALOG OUTPUT** submenu, located under the **SETUP → MORE → DIAG** menu is used to verify that the M300E/EM Analyzer's analog outputs are working properly. The test generates a signal on functioning outputs simultaneously as shown in the following table.

Table 13-10: Analog Output Test Function - Nominal Values Voltage Outputs

		FULL SCALE OUTPUT OF VOLTAGE RANGE (see Section 7.4.2)			
		100MV	**1V**	**5V**	**10V**
STEP	**%**	**NOMINAL OUTPUT VOLTAGE**			
1	0	0	0	0	0
2	20	20 mV	0.2	1	2
3	40	40 mV	0.4	2	4
4	60	60 mV	0.6	3	6
5	80	80 mV	0.8	4	8
6	100	100 mV	1.0	5	10

For each of the steps the output should be within 1% of the nominal value listed in the table below except for the 0% step, which should be within 0mV ±2 mV. Make sure you take into account any offset that may have been programmed into channel (see Section 7.4.5).

If one or more of the steps fails to be within these ranges, it is likely that there has been a failure of either or both of the DACs and their associated circuitry on the motherboard. To perform the test connect a voltmeter to the output in question and perform an analog output step test as follows:



13.5.7.3. Analog Outputs: Current Loop

To verify that the analog outputs with the optional current mode output are working properly, connect a 250 ohm resistor across the outputs and use a voltmeter to measure the output as described in Section 7.4.3.4 and then perform an analog output step test as described in Section 13.5.7.2.

For each step the output should be within 1% of the nominal value listed in the table below.

Table 13-11: Analog Output Test Function - Nominal Values Voltage Outputs

		OUTPUT RANGE			
		2 -20		4 -20	
		NOMINAL OUTPUT VALUES			
STEP	%	CURRENT	V(250 OHMS)	CURRENT	V(250 OHMS)
1	0	2 mA	0.5V	4	1
2	20	5.6	1.4	7.2	1.8
3	40	9.2	2.3	10.4	2.6
4	60	12.8	3.2	13.6	3.4
5	80	16.4	4.1	16.8	4.2
6	100	20	5	20	5

13.5.7.4. **Status Outputs**

The procedure below can be used to test the Status outputs:

1. Connect a jumper between the “D“ pin and the “▽” pin on the status output connector.
2. Connect a 1000 ohm resistor between the “+” pin and the pin for the status output that is being tested.
3. Connect a voltmeter between the “▽” pin and the pin of the output being tested (see table below).

Under the **DIAG→** SIGNAL I/O menu (see Section 13.1.3), scroll through the inputs and outputs until you get to the output in question. Alternately turn on and off the output noting the voltage on the voltmeter, it should vary between 0 volts for ON and 5 volts for OFF.

Table 13-12: Status Outputs Check

PIN (LEFT TO RIGHT)	STATUS
1	SYSTEM OK
2	CONC VALID
3	HIGH RANGE
4	ZERO CAL
5	SPAN CAL
6	DIAG MODE
7	SPARE
8	SPARE

13.5.7.5. **Control Inputs – Remote Zero, Span**

The control input bits can be tested by the following procedure:

1. Connect a jumper from the +5 pin on the Status connector to the U on the Control In connector.
2. Connect a second jumper from the ⏚ pin on the Status connector to the A pin on the Control In connector. The instrument should switch from Sample Mode to ZERO CAL R mode.
3. Connect a second jumper from the ⏚ pin on the Status connector to the B pin on the Control In connector. The instrument should switch from Sample Mode to SPAN CAL R mode.
4. In each case, the M300E/EM should return to Sample Mode when the jumper is removed.

13.5.8. **CPU**

There are two major types of failures associated with the CPU board: complete failure and a failure associated with the Disk-On-Module on the CPU board. If either of these failures occurs, contact the factory.

1. For complete failures, assuming that the power supplies are operating properly and the wiring is intact, the CPU is bad if on powering the instrument:
   - The vacuum fluorescent display shows a dash in the upper left hand corner.
   - The CPU Status LED, DS5, is not flashing. See Section 13.1.4.1.
   - There is no activity from the primary RS-232 port on the rear panel even if “? <ret>” is pressed.
   - In some rare circumstances this failure may be caused by a bad IC on the motherboard, specifically U57 the large, 44 pin device on the lower right hand side of the board. If this is true, removing U57 from its socket will allow the instrument to startup but the measurements will be incorrect.
2. If the analyzer stops part way through initialization (the vacuum fluorescent display “freezes”) then it is likely that the DOM has been corrupted.

13.5.9. **RS-232 COMMUNICATIONS**

13.5.9.1. **General RS-232 Troubleshooting**

Teledyne API analyzers use the RS-232 communications protocol to allow the instrument to be connected to a variety of computer-based equipment. RS-232 has been used for many years and as equipment has become more advanced, connections between various types of hardware have become increasingly difficult. Generally, every manufacturer observes the signal and timing requirements of the protocol very carefully.

Problems with RS-232 connections usually center around 4 general areas:

1. Incorrect cabling and connectors. See Section 3.3 for connector and pin-out information.
2. The BAUD rate and protocol are incorrectly configured. See Section 8.1.3.
3. If a modem is being used, additional configuration and wiring rules must be observed. See Section 8.2
4. Incorrect setting of the DTE-DCE Switch. Ensure that switch is set correctly. See Section 8.1.1.
5. Verify that cable (P/N 03596) that connects the serial COM ports of the CPU to J12 of the motherboard is properly seated.

13.5.9.2. **Troubleshooting Analyzer/Modem or Terminal Operation**

These are the general steps for troubleshooting problems with a modem connected to a Teledyne API analyzer.

1. Check cables for proper connection to the modem, terminal or computer.
2. Check to make sure the DTE-DCE is in the correct position as described in Section 8.1.1.
3. Check to make sure the set up command is correct. See Section 8.2.
4. Verify that the Ready to Send (RTS) signal is at logic high. The M300E/EM sets pin 7 (RTS) to greater than 3 volts to enable modem transmission.
5. Make sure the BAUD rate, word length, and stop bit settings between modem and analyzer match. See Section 8.2.
6. Use the RS-232 test function to send "w" characters to the modem, terminal or computer. See Section 8.2.
7. Get your terminal, modem or computer to transmit data to the analyzer (holding down the space bar is one way); the green LED should flicker as the instrument is receiving data.
8. Make sure that the communications software or terminal emulation software is functioning properly.

Further help with serial communications is available in a separate manual "RS-232 Programming Notes" Teledyne API P/N 013500000.

13.5.10. THE OPTIONAL CO_2 SENSOR

There are Two LED's located on the CO_2 sensor PCA.

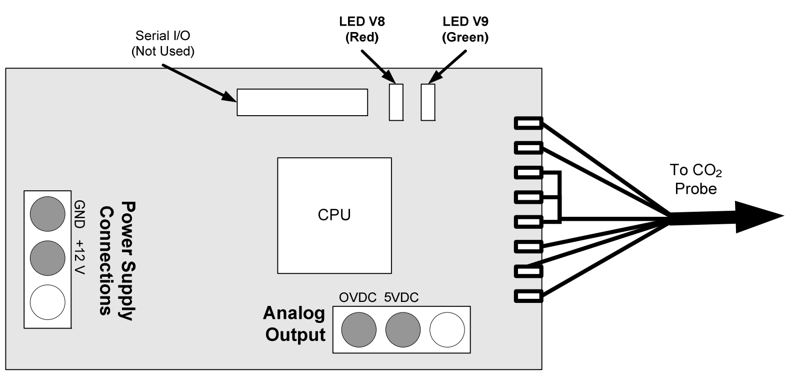


Figure 13-13: Location of Diagnostic LED's onCO$_2$ Sensor PCA

- Normal Operation: V8 is not lit – V9 is Blinking
- Error State: Both LED's are blinking.

Check to make sure that the cable to the CO_2 probe is properly connected.

13.6. **REPAIR PROCEDURES**

This contains procedures that might need to be performed on rare occasions when a major component of the analyzer requires repair or replacement.

13.6.1. **REPAIRING SAMPLE FLOW CONTROL ASSEMBLY**

The critical flow orifice is housed in the flow control assembly (Teledyne API P/N 001760400) located on the top of the optical bench. A sintered filter protects the jewel orifice so it is unusual for the orifice to need replacing, but if it does, or the filter needs replacement please use the following procedure (see the Spare Parts list in Appendix B for part numbers and kits):

1. Turn off power to the analyzer.
2. Locate the assembly attached to the sample pump. See Figure 3-4.
3. Disconnect the pneumatic connection from the flow assembly and the assembly from the pump.
4. Remove the fitting and the components as shown in the exploded view below.
5. Replace the o-rings (P/N OR0000001) and the sintered filter (P/N FL0000001).
6. If replacing the critical flow orifice itself (P/N 000941000), make sure that the side with the colored window (usually red) is facing upstream to the flow gas flow.
7. Apply new Teflon® tape to the male connector threads.
8. Re-assemble in reverse order.
9. After reconnecting the power and pneumatic lines, flow check the instrument as described in Section 12.3.4.

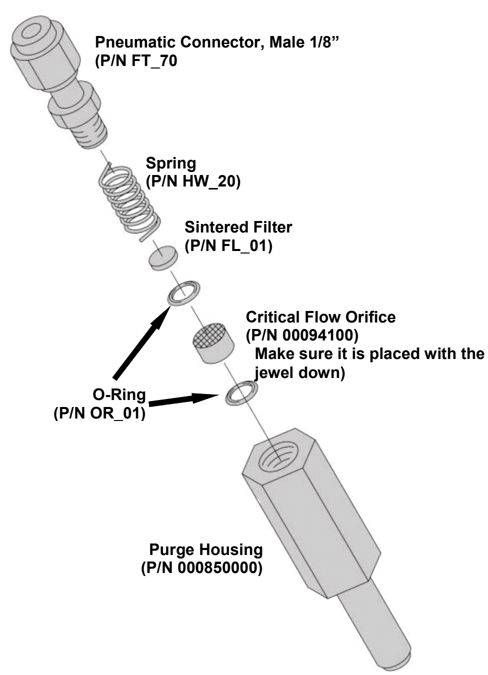


Figure 13-14: Critical Flow Restrictor Assembly Disassembly

13.6.2. REMOVING/REPLACING THE GFC WHEEL

When removing or replacing the GFC Wheel it is important to perform the disassembly in the following order to avoid damaging the components:

1. Turn off the analyzer.
2. Remove the top cover.
3. Open the instrument's hinged front panel.
4. Locate the GFC Wheel/motor assembly. See Figure 3-4.
5. Unplug the following electronic components:
   - The GFC Wheel housing temperature sensor
   - GFC Wheel heater
   - GFC Wheel motor power supply

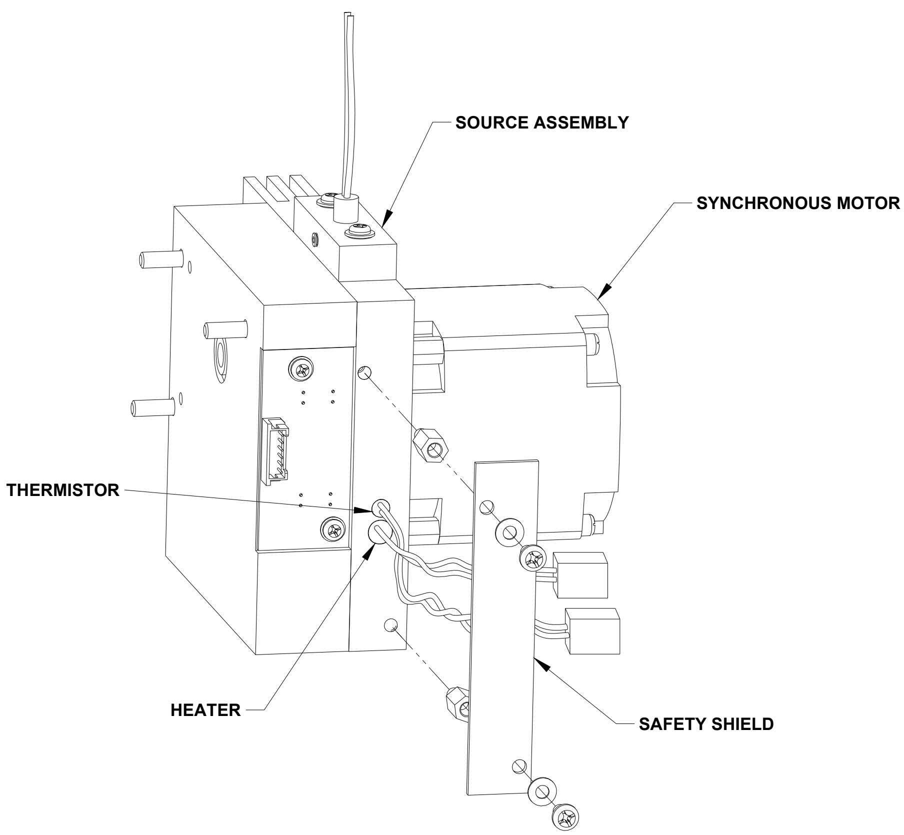


Figure 13-15: Opening the GFC Wheel Housing

6. Remove the three (3) screws holding the opto-pickup printed circuit assembly to the GFC Wheel housing.

7. Carefully remove the opto-pickup printed circuit assembly.

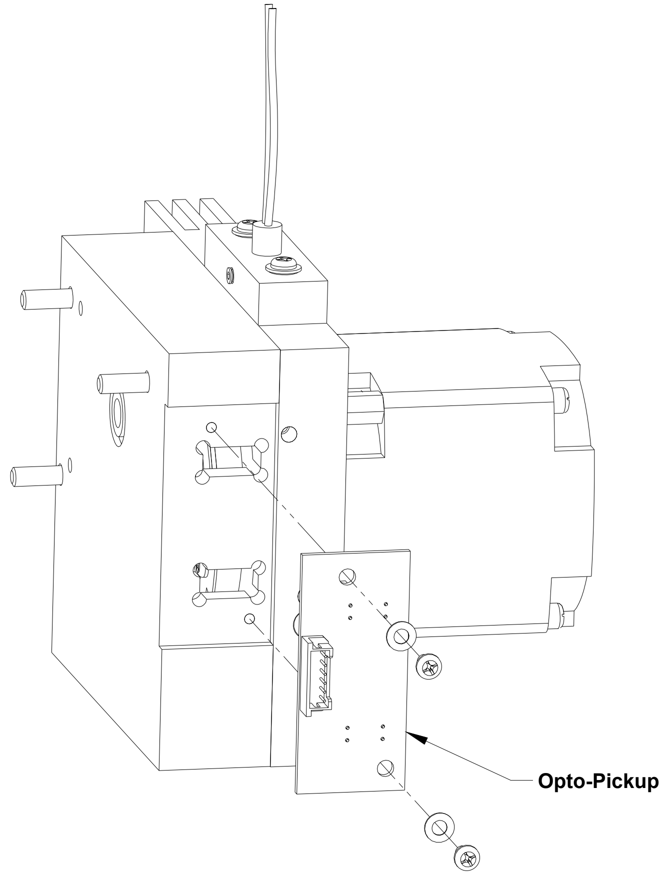


Figure 13-16: Removing the Opto-Pickup Assembly

8. Remove the four (4) screws holding the GFC Wheel motor/heat sink assembly to the GFC Wheel housing.
9. Carefully remove the GFC Wheel motor/heat sink assembly from the GFC Wheel housing.

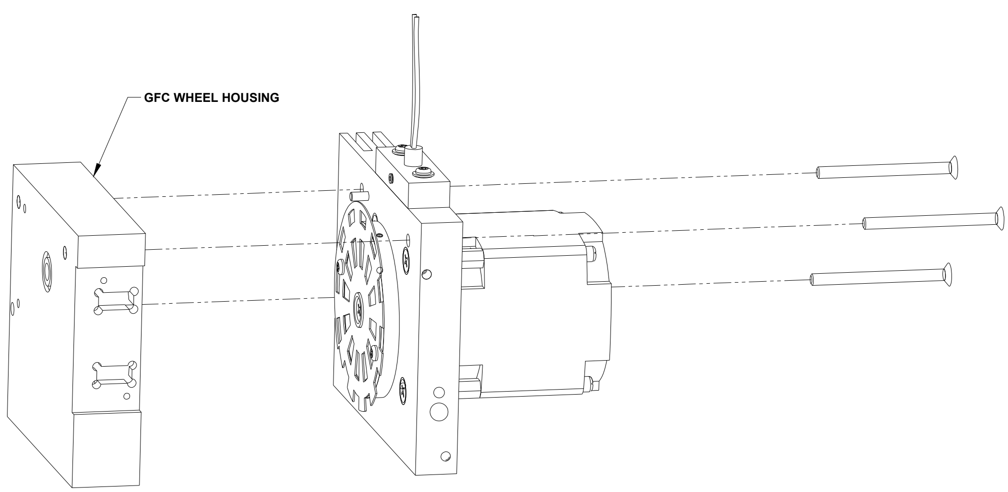


Figure 13-17: Removing the GFC Wheel Housing

10. Remove the one (1) screw fastening the GFC Wheel/mask assembly to the GFC motor hub.

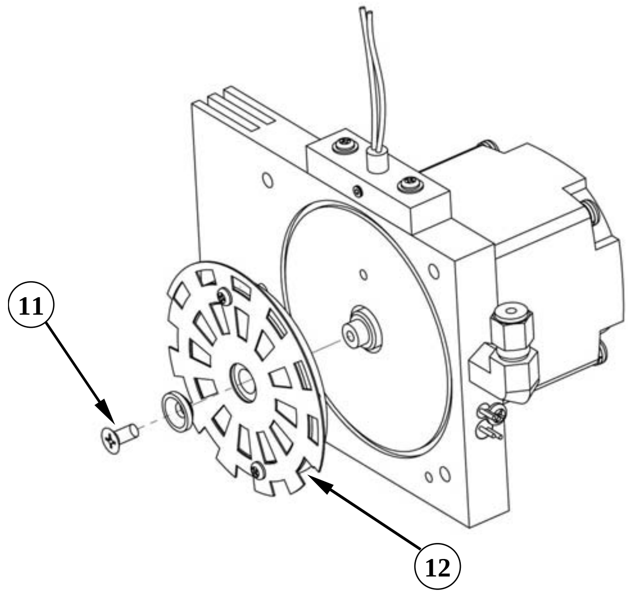


Figure 13-18: Removing the GFC Wheel

11. Remove the GFC Wheel/mask assembly.
12. Follow the previous steps in reverse order to put the GFC Wheel/motor assembly back together.

13.6.3. CHECKING AND ADJUSTING THE SYNC/DEMODULATOR, CIRCUIT GAIN (CO MEAS)

13.6.3.1. Checking the Sync/Demodulator Circuit Gain

The M300E/EM Analyzers will operate accurately as long as the sync/demodulator circuit gain is properly adjusted. To determine if this gain factor is correct:

1. Make sure that the analyzer is turned on and warmed up.
2. Set the analyzer display to show the **STABIL** or **CO STB** test function.
3. Apply Zero Air to Sample Inlet of the analyzer.
4. Wait until the stability reading falls below 1.0 ppm.
5. Change the analyzer display to show the **CO MEAS**
   - The value of **CO MEAS** must be > 2800 mV and < 4800 mV for the instrument to operate correctly.
   - Optimal value for **CO MEAS** is 4500 mV ± 300 mV. If it is not, adjust the value.

13.6.3.2. **Adjusting the Sync/Demodulator, Circuit Gain**

To adjust the sync/demodulator circuit gain:

1. Make sure that the analyzer is turned on and warmed up.
2. Set the analyzer display to show the **STABIL** or **CO STB** test function.
3. Apply Zero Air to Sample Inlet of the analyzer.
4. Wait until the stability reading falls below 1.0 ppm.
5. Change the analyzer display to show the **CO MEAS.**
6. Remove the Sync/Demod Housing
   - Remove the two mounting screws.
   - Carefully lift the housing to reveal the sync/demod PCA.

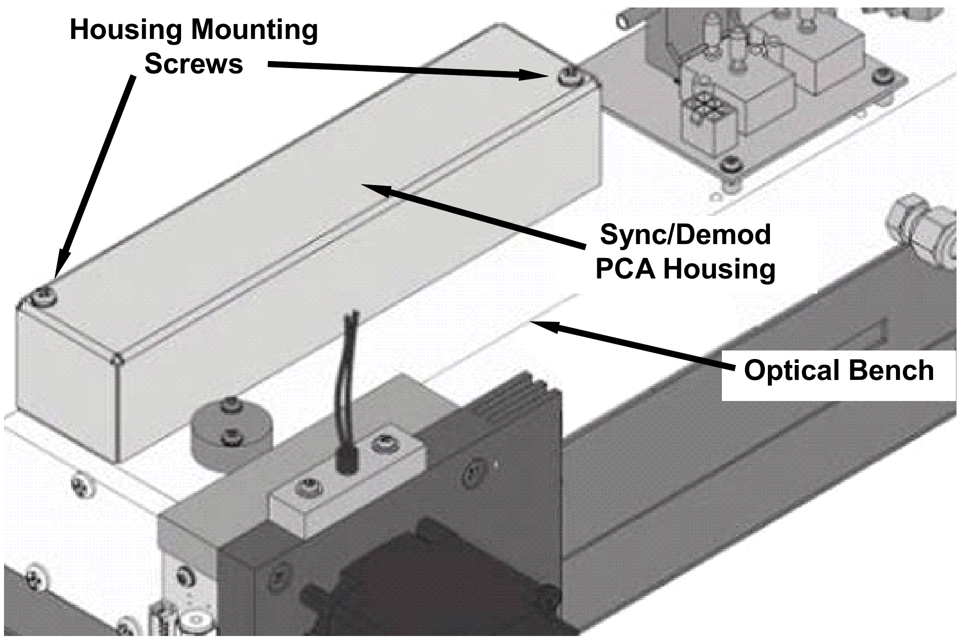


Figure 13-19: Location of Sync/Demod Housing Mounting Screws

7. Adjust potentiometer VR1 until **CO MEAS** reads 4500 mV ± 300 mV

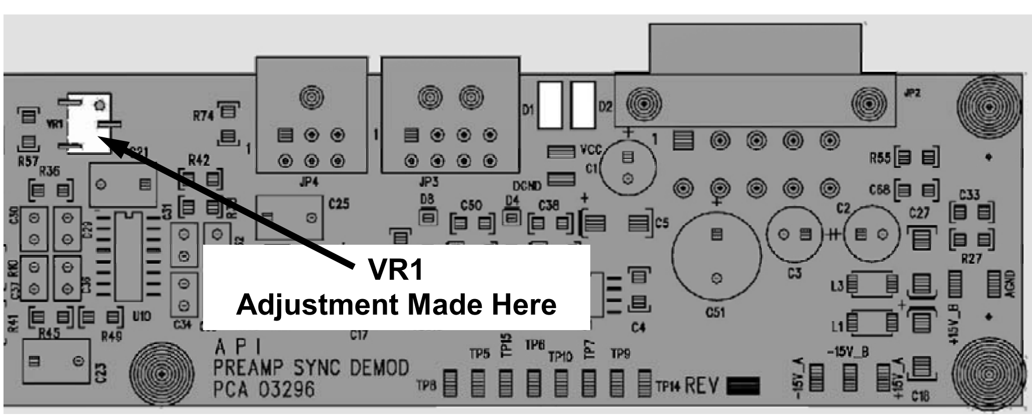


Figure 13-20: Location of Sync/Demod Gain Potentiometer

13.6.4. DISK-ON-MODULE REPLACEMENT PROCEDURE

Replacing the Disk-on-Module (DOM) will cause loss of all DAS data; it also may cause loss of some instrument configuration parameters unless the replacement DOM carries the exact same firmware version. Whenever changing the version of installed software, the memory must be reset. Failure to ensure that memory is reset can cause the analyzer to malfunction, and invalidate measurements. After the memory is reset, the A/D converter must be re-calibrated, and all information collected in Step 1 below must be re-entered before the instrument will function correctly. Also, zero and span calibration should be performed.

1. Document all analyzer parameters that may have been changed, such as range, auto-cal, analog output, serial port and other settings before replacing the DOM
2. Turn off power to the instrument, fold down the rear panel by loosening the mounting screws.
3. When looking at the electronic circuits from the back of the analyzer, locate the Disk-on-Module in the right most socket of the CPU board.
4. The DOM should carry a label with firmware revision, date and initials of the programmer.
5. Remove the nylon fastener that mounts the DOM over the CPU board, and lift the DOM off the CPU. Do not bend the connector pins.
6. Install the new Disk-on-Module, making sure the notch at the end of the chip matches the notch in the socket.
7. It may be necessary to straighten the pins somewhat to fit them into the socket. Press the DOM all the way in and reinsert the offset clip.
8. Close the rear panel and turn on power to the machine.
9. If the replacement DOM carries a firmware revision, re-enter all of the setup information.

13.7. TECHNICAL ASSISTANCE

If this manual and its troubleshooting / repair sections do not solve your problems, technical assistance may be obtained from:

Teledyne API, Customer Service,
9480 Carroll Park Drive
San Diego, California 92121-5201USA

Toll-free Phone: 800-324-5190
Phone: 858-657-9800
Fax: 858-657-9816
Email: api-customerservice@teledyne.com
Website: http://www.teledyne-api.com/

Before you contact Teledyne API Customer service, fill out the problem report form in Appendix C, which is also available online for electronic submission at http://www.teledyne-api.com/forms/.

14. A PRIMER ON ELECTRO-STATIC DISCHARGE

Teledyne API considers the prevention of damage caused by the discharge of static electricity to be extremely important part of making sure that your analyzer continues to provide reliable service for a long time. This section describes how static electricity occurs, why it is so dangerous to electronic components and assemblies as well as how to prevent that damage from occurring.

14.1. HOW STATIC CHARGES ARE CREATED

Modern electronic devices such as the types used in the various electronic assemblies of your analyzer, are very small, require very little power and operate very quickly. Unfortunately, the same characteristics that allow them to do these things also make them very susceptible to damage from the discharge of static electricity. Controlling electrostatic discharge begins with understanding how electro-static charges occur in the first place.

Static electricity is the result of something called triboelectric charging which happens whenever the atoms of the surface layers of two materials rub against each other. As the atoms of the two surfaces move together and separate, some electrons from one surface are retained by the other.

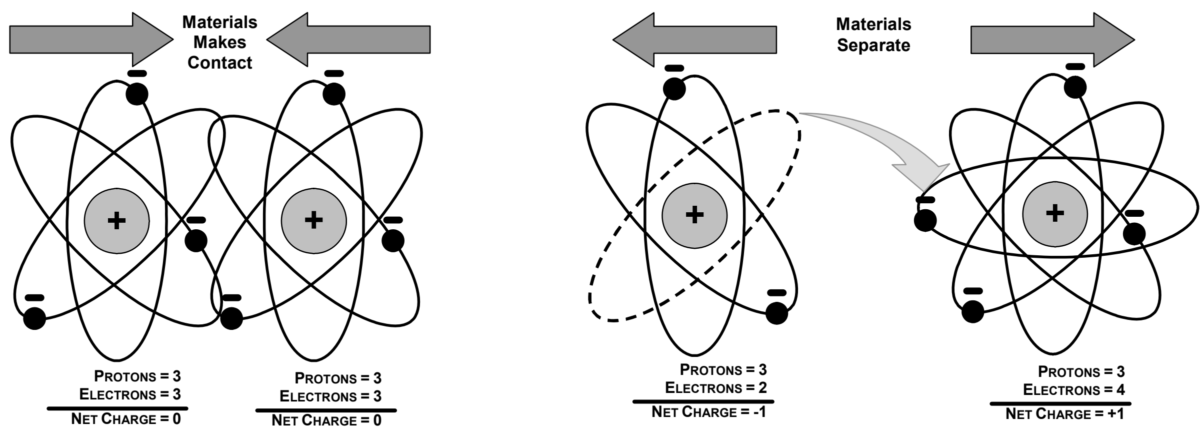


Figure 14-1: Triboelectric Charging

If one of the surfaces is a poor conductor or even a good conductor that is not grounded, the resulting positive or negative charge cannot bleed off and becomes trapped in place, or static. The most common example of triboelectric charging happens when someone wearing leather or rubber soled shoes walks across a nylon carpet or linoleum tiled floor. With each step, electrons change places and the resulting electro-static charge builds up, quickly reaching significant levels. Pushing an epoxy printed circuit board across a workbench, using a plastic handled screwdriver or even the constant jostling of Styrofoam™ pellets during shipment can also build hefty static charges.

Table 14-1: Static Generation Voltages for Typical Activities

MEANS OF GENERATION	65-90% RH	10-25% RH
Walking across nylon carpet	1,500V	35,000V
Walking across vinyl tile	250V	12,000V
Worker at bench	100V	6,000V
Poly bag picked up from bench	1,200V	20,000V
Moving around in a chair padded with urethane foam	1,500V	18,000V

14.2. HOW ELECTRO-STATIC CHARGES CAUSE DAMAGE

Damage to components occurs when these static charges come into contact with an electronic device. Current flows as the charge moves along the conductive circuitry of the device and the typically very high voltage levels of the charge overheat the delicate traces of the integrated circuits, melting them or even vaporizing parts of them. When examined by microscope the damage caused by electro-static discharge looks a lot like tiny bomb craters littered across the landscape of the component's circuitry.

A quick comparison of the values in Table 14-1 with the those shown in the Table 14-2, listing device susceptibility levels, shows why *Semiconductor Reliability News* estimates that approximately 60% of device failures are the result of damage due to electro-static discharge.

Table 14-2: Sensitivity of Electronic Devices to Damage by ESD

DEVICE	DAMAGE SUSCEPTIBILITY VOLTAGE RANGE	
	DAMAGE BEGINS OCCURRING AT	CATASTROPHIC DAMAGE AT
MOSFET	10	100
VMOS	30	1800
NMOS	60	100
GaAsFET	60	2000
EPROM	100	100
JFET	140	7000
SAW	150	500
Op-AMP	190	2500
CMOS	200	3000
Schottky Diodes	300	2500
Film Resistors	300	3000
This Film Resistors	300	7000
ECL	500	500
SCR	500	1000
Schottky TTL	500	2500

Potentially damaging electro-static discharges can occur:

Any time a charged surface (including the human body) discharges to a device. Even simple contact of a finger to the leads of a sensitive device or assembly can allow enough discharge to cause damage. A similar discharge can occur from a charged conductive object, such as a metallic tool or fixture.

When static charges accumulated on a sensitive device discharges from the device to another surface such as packaging materials, work surfaces, machine surfaces or other device. In some cases, charged device discharges can be the most destructive.

A typical example of this is the simple act of installing an electronic assembly into the connector or wiring harness of the equipment in which it is to function. If the assembly is carrying a static charge, as it is connected to ground a discharge will occur.

Whenever a sensitive device is moved into the field of an existing electro-static field, a charge may be induced on the device in effect discharging the field onto the device. If the device is then momentarily grounded while within the electrostatic field or removed from the region of the electrostatic field and grounded somewhere else, a second discharge will occur as the charge is transferred from the device to ground.

14.3. COMMON MYTHS ABOUT ESD DAMAGE

I didn't feel a shock so there was no electro-static discharge: The human nervous system isn't able to feel a static discharge of less than 3500 volts. Most devices are damaged by discharge levels much lower than that.

I didn't touch it so there was no electro-static discharge: Electro Static charges are fields whose lines of force can extend several inches or sometimes even feet away from the surface bearing the charge.

It still works so there was no damage: Sometimes the damaged caused by electro-static discharge can completely sever a circuit trace causing the device to fail immediately. More likely, the trace will be only partially occluded by the damage causing degraded performance of the device or worse, weakening the trace. This weakened circuit may seem to function fine for a short time, but even the very low voltage and current levels of the device's normal operating levels will eat away at the defect over time causing the device to fail well before its designed lifetime is reached.

These latent failures are often the most costly since the failure of the equipment in which the damaged device is installed causes down time, lost data, lost productivity, as well as possible failure and damage to other pieces of equipment or property.

Static Charges can't build up on a conductive surface: There are two errors in this statement.

Conductive devices can build static charges if they are not grounded. The charge will be equalized across the entire device, but without access to earth ground, they are still trapped and can still build to high enough levels to cause damage when they are discharged.

A charge can be induced onto the conductive surface and/or discharge triggered in the presence of a charged field such as a large static charge clinging to the surface of a nylon jacket of someone walking up to a workbench.

As long as my analyzer is properly installed, it is safe from damage caused by static discharges: It is true that when properly installed the chassis ground of your analyzer is tied to earth ground and its electronic components are prevented from building static electric charges themselves. This does not prevent discharges from static fields built up on other things, like you and your clothing, from discharging through the instrument and damaging it.

14.4. BASIC PRINCIPLES OF STATIC CONTROL

It is impossible to stop the creation of instantaneous static electric charges. It is not, however difficult to prevent those charges from building to dangerous levels or prevent damage due to electro-static discharge from occurring.

14.4.1. GENERAL RULES

Only handle or work on all electronic assemblies at a properly set up ESD station. Setting up an ESD safe workstation need not be complicated. A protective mat properly tied to ground and a wrist strap are all that is needed to create a basic anti-ESD workstation.

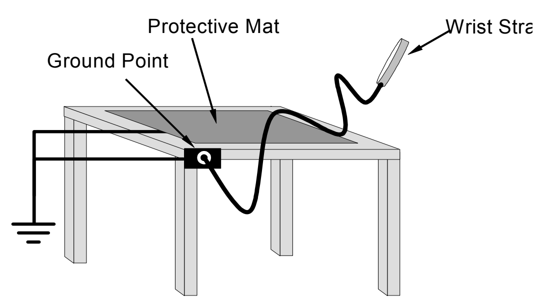


Figure 14-2: Basic anti-ESD Workbench

For technicians that work in the field, special lightweight and portable anti-ESD kits are available from most suppliers of ESD protection gear. These include everything needed to create a temporary anti-ESD work area anywhere.

Always wear an Anti-ESD wrist strap when working on the electronic assemblies of your analyzer. An anti-ESD wrist strap keeps the person wearing it at or near the same potential as other grounded objects in the work area and allows static charges to dissipate before they can build to dangerous levels. Anti-ESD wrist straps terminated with alligator clips are available for use in work areas where there is no available grounded plug.

Also, anti-ESD wrist straps include a current limiting resistor (usually around one meg-ohm) that protects you should you accidentally short yourself to the instrument's power supply.

Simply touching a grounded piece of metal is insufficient. While this may temporarily bleed off static charges present at the time, once you stop touching the grounded metal new static charges will immediately begin to re-build. In some conditions, a charge large enough to damage a component can rebuild in just a few seconds.

Always store sensitive components and assemblies in anti-ESD storage bags or bins: Even when you are not working on them, store all devices and assemblies in a closed anti-Static bag or bin. This will prevent induced charges from building up on the device or assembly and nearby static fields from discharging through it.

Use metallic anti-ESD bags for storing and shipping ESD sensitive components and assemblies rather than pink-poly bags. The famous, pink-poly bags are made of a plastic that is impregnated with a liquid (similar to liquid laundry detergent) which very slowly sweats onto the surface of the plastic creating a slightly conductive layer over the surface of the bag.

While this layer may equalizes any charges that occur across the whole bag, it does not prevent the build up of static charges. If laying on a conductive, grounded surface, these bags will allow charges to bleed away but the very charges that build up on the surface of the bag itself can be transferred through the bag by induction onto the circuits of your ESD sensitive device. Also, the liquid impregnating the plastic is eventually used up after which the bag is as useless for preventing damage from ESD as any ordinary plastic bag.

Anti-Static bags made of plastic impregnated with metal (usually silvery in color) provide all of the charge equalizing abilities of the pink-poly bags but also, when properly sealed, create a Faraday cage that completely isolates the contents from discharges and the inductive transfer of static charges.

Storage bins made of plastic impregnated with carbon (usually black in color) are also excellent at dissipating static charges and isolating their contents from field effects and discharges.

Never use ordinary plastic adhesive tape near an ESD sensitive device or to close an anti-ESD bag. The act of pulling a piece of standard plastic adhesive tape, such as Scotch® tape, from its roll will generate a static charge of several thousand or even tens of thousands of volts on the tape itself and an associated field effect that can discharge through or be induced upon items up to a foot away.

14.4.2. BASIC ANTI-ESD PROCEDURES FOR ANALYZER REPAIR AND MAINTENANCE

14.4.2.1. Working at the Instrument Rack

When working on the analyzer while it is in the instrument rack and plugged into a properly grounded power supply:

1. Attach you anti-ESD wrist strap to ground before doing anything else.

   Use a wrist strap terminated with an alligator clip and attach it to a bare metal portion of the instrument chassis.

   This will safely connect you to the same ground level to which the instrument and all of its components are connected.
2. Pause for a second or two to allow any static charges to bleed away.
3. Open the casing of the analyzer and begin work. Up to this point, the closed metal casing of your analyzer has isolated the components and assemblies inside from any conducted or induced static charges.
4. If you must remove a component from the instrument, do not lay it down on a non-ESD preventative surface where static charges may lie in wait.
5. Only disconnect your wrist strap after you have finished work and closed the case of the analyzer.

14.4.2.2. Working at an Anti-ESD Work Bench

When working on an instrument of an electronic assembly while it is resting on a anti-ESD workbench:

1. Plug you anti-ESD wrist strap into the grounded receptacle of the work station before touching any items on the work station and while standing at least a foot or so away. This will allow any charges you are carrying to bleed away through the ground connection of the workstation and prevent discharges due to field effects and induction from occurring.
2. Pause for a second or two to allow any static charges to bleed away.
3. Only open any anti-ESD storage bins or bags containing sensitive devices or assemblies after you have plugged your wrist strap into the workstation.

   Lay the bag or bin on the workbench surface.

   Before opening the container, wait several seconds for any static charges on the outside surface of the container to be bled away by the workstation's grounded protective mat.
4. Do not pick up tools that may be carrying static charges while also touching or holding an ESD sensitive device.

   Only lay tools or ESD-sensitive devices and assemblies on the conductive surface of your workstation. Never lay them down on any non-ESD preventative surface.
5. Place any static sensitive devices or assemblies in anti-static storage bags or bins and close the bag or bin before unplugging your wrist strap.
6. Disconnecting your wrist strap is always the last action taken before leaving the workbench.

14.4.2.3. Transferring Components from Rack to Bench and Back

When transferring a sensitive device from an installed Teledyne API analyzer to an anti-ESD workbench or back:

1. Follow the instructions listed above for working at the instrument rack and workstation.
2. Never carry the component or assembly without placing it in an anti-ESD bag or bin.
3. Before using the bag or container allow any surface charges on it to dissipate:

   If you are at the instrument rack, hold the bag in one hand while your wrist strap is connected to a ground point.

   If you are at an anti-ESD workbench, lay the container down on the conductive work surface.

   In either case wait several seconds.
4. Place the item in the container.
5. Seal the container. If using a bag, fold the end over and fastening it with anti-ESD tape.

   Folding the open end over isolates the component(s) inside from the effects of static fields.

   Leaving the bag open or simply stapling it shut without folding it closed prevents the bag from forming a complete protective envelope around the device.
6. Once you have arrived at your destination, allow any surface charges that may have built up on the bag or bin during travel to dissipate:

   Connect your wrist strap to ground.

   If you are at the instrument rack, hold the bag in one hand while your wrist strap is connected to a ground point.

   If you are at a anti-ESD workbench, lay the container down on the conductive work surface

   In either case wait several seconds
7. Open the container.

14.4.2.4. Opening Shipments from Teledyne API' Customer Service

Packing materials such as bubble pack and Styrofoam pellets are extremely efficient generators of static electric charges. To prevent damage from ESD, Teledyne API ships all electronic components and assemblies in properly sealed anti-ESD containers.

Static charges will build up on the outer surface of the anti-ESD container during shipping as the packing materials vibrate and rub against each other. To prevent these static charges from damaging the components or assemblies being shipped make sure that you:

Always unpack shipments from Teledyne API Customer Service by:

1. Opening the outer shipping box away from the anti-ESD work area.
2. Carry the still sealed anti-ESD bag, tube or bin to the anti-ESD work area.
3. Follow steps 6 and 7 of Section 14.4.2.3 above when opening the anti-ESD container at the work station.
4. Reserve the anti-ESD container or bag to use when packing electronic components or assemblies to be returned to Teledyne API.

14.4.2.5. **Packing Components for Return to Teledyne API's Customer Service**

CAUTION – Avoid Warranty Invalidation

Failure to comply with proper anti-Electro-Static Discharge (ESD) handling and packing instructions and Return Merchandise Authorization (RMA) procedures when returning parts for repair or calibration may void your warranty. For anti-ESD handling and packing instructions please refer to "Packing Components for Return to Teledyne API's Customer Service" in the *Primer on Electro-Static Discharge* section of this manual, and for RMA procedures please refer to our Website at http://www.teledyne-api.com under Customer Support > Return Authorization.

Always pack electronic components and assemblies to be sent to Teledyne API's Customer Service in anti-ESD bins, tubes or bags.

CAUTION

ESD Hazard

- **DO NOT use pink-poly bags.**
- **NEVER allow any standard plastic packaging materials to touch the electronic component/assembly directly.**
  - **This includes, but is not limited to, plastic bubble-pack, Styrofoam peanuts, open cell foam, closed cell foam, and adhesive tape.**
- **DO NOT use standard adhesive tape as a sealer. Use ONLY anti-ESD tape.**

Never carry the component or assembly without placing it in an anti-ESD bag or bin.

1. Before using the bag or container allow any surface charges on it to dissipate:

   If you are at the instrument rack, hold the bag in one hand while your wrist strap is connected to a ground point.

   If you are at an anti-ESD workbench, lay the container down on the conductive work surface.

   In either case wait several seconds.
2. Place the item in the container.
3. Seal the container. If using a bag, fold the end over and fastening it with anti-ESD tape.

   Folding the open end over isolates the component(s) inside from the effects of static fields.

   Leaving the bag open or simply stapling it shut without folding it closed prevents the bag from forming a complete protective envelope around the device.

NOTE

If you do not already have an adequate supply of anti-ESD bags or containers available, Teledyne API's Customer Service department will supply them (see Section 13.7 for contact information).

Follow the instructions listed above for working at the instrument rack and workstation.

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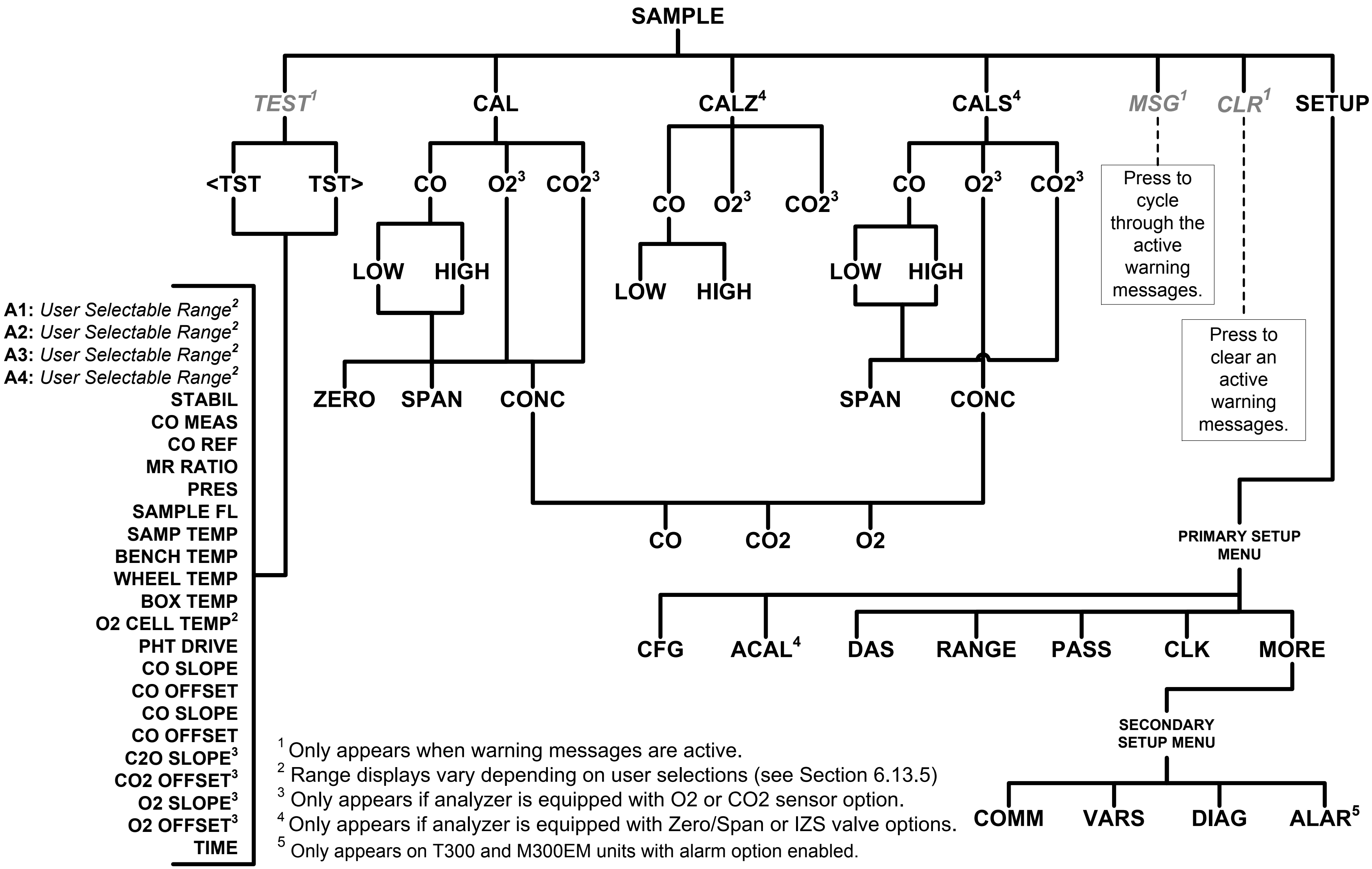
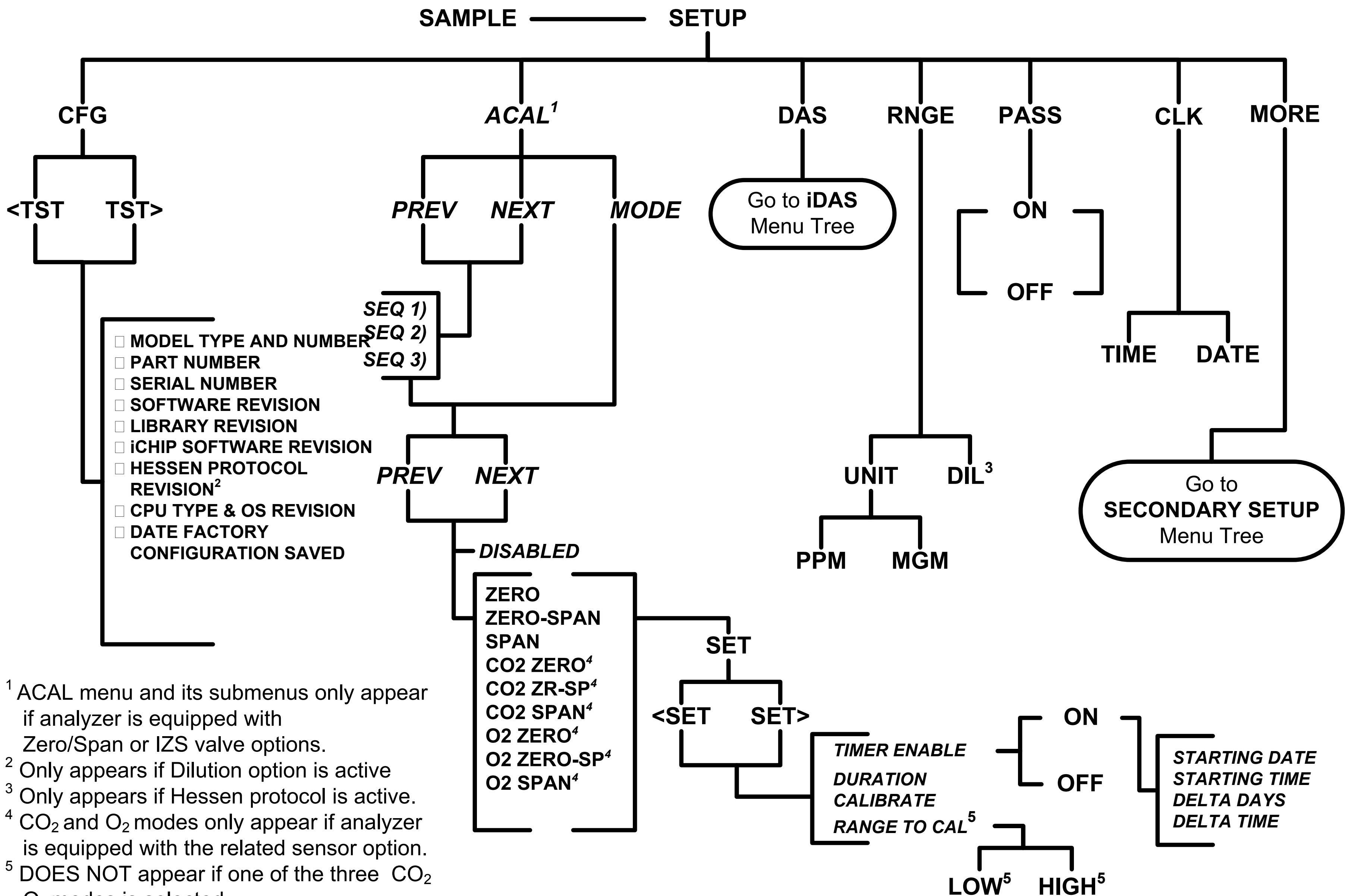
APPENDIX A - Version Specific Software Documentation

APPENDIX A-1: Software Menu Trees, Revision L.8



[1] Only appears when warning messages are active.
[2] Range displays vary depending on user selections (see Section 6.13.5)
[3] Only appears if analyzer is equipped with O2 or CO2 sensor option.
[4] Only appears if analyzer is equipped with Zero/Span or IZS valve options.
[5] Only appears on T300 and M300EM units with alarm option enabled.

Figure A-1: Basic Sample Display Menu



[1] ACAL menu and its submenus only appear if analyzer is equipped with Zero/Span or IZS valve options.

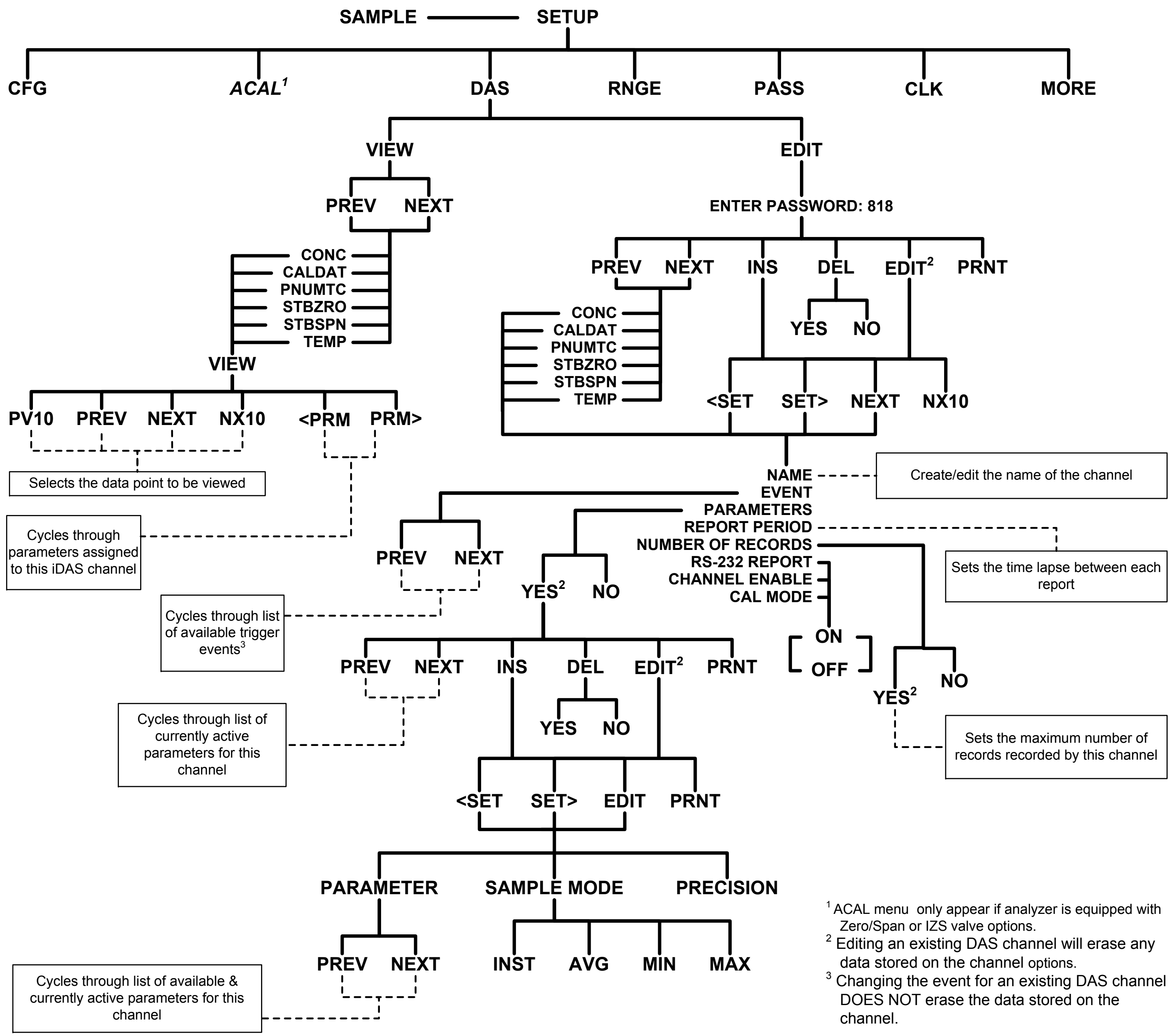
[2] Only appears if Dilution option is active

[3] Only appears if Hessen protocol is active.

[4] CO_2 and O_2 modes only appear if analyzer is equipped with the related sensor option.

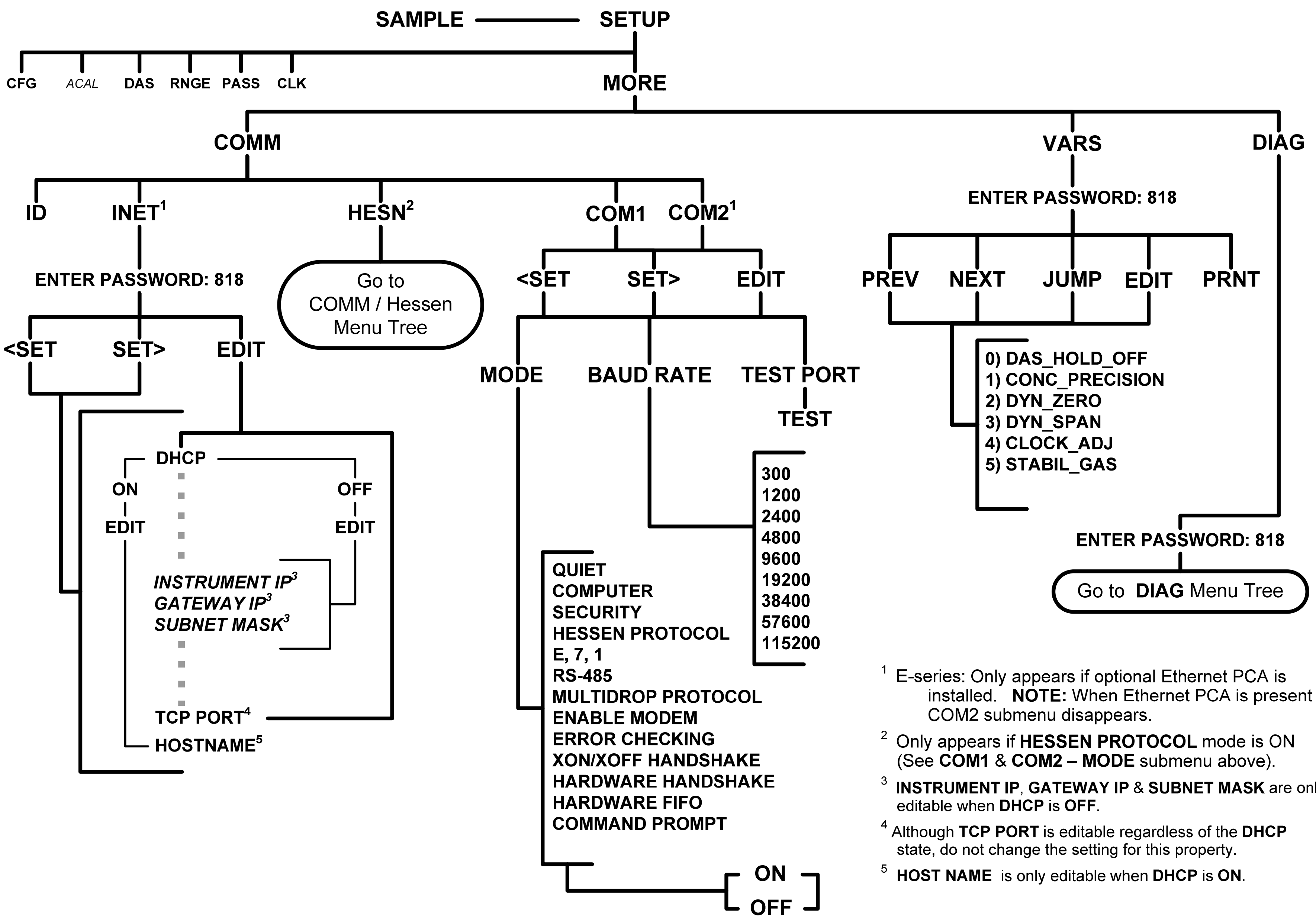
[5] DOES NOT appear if one of the three CO_2 O_2 modes is selected

Figure A-2: Primary Setup Menu (Except DAS)



[1] ACAL menu only appear if analyzer is equipped with Zero/Span or IZS valve options.
[2] Editing an existing DAS channel will erase any data stored on the channel options.
[3] Changing the event for an existing DAS channel DOES NOT erase the data stored on the channel.

Figure A-3: Primary Setup Menu → DAS Submenu



[1] E-series: Only appears if optional Ethernet PCA is installed. **NOTE:** When Ethernet PCA is present COM2 submenu disappears.

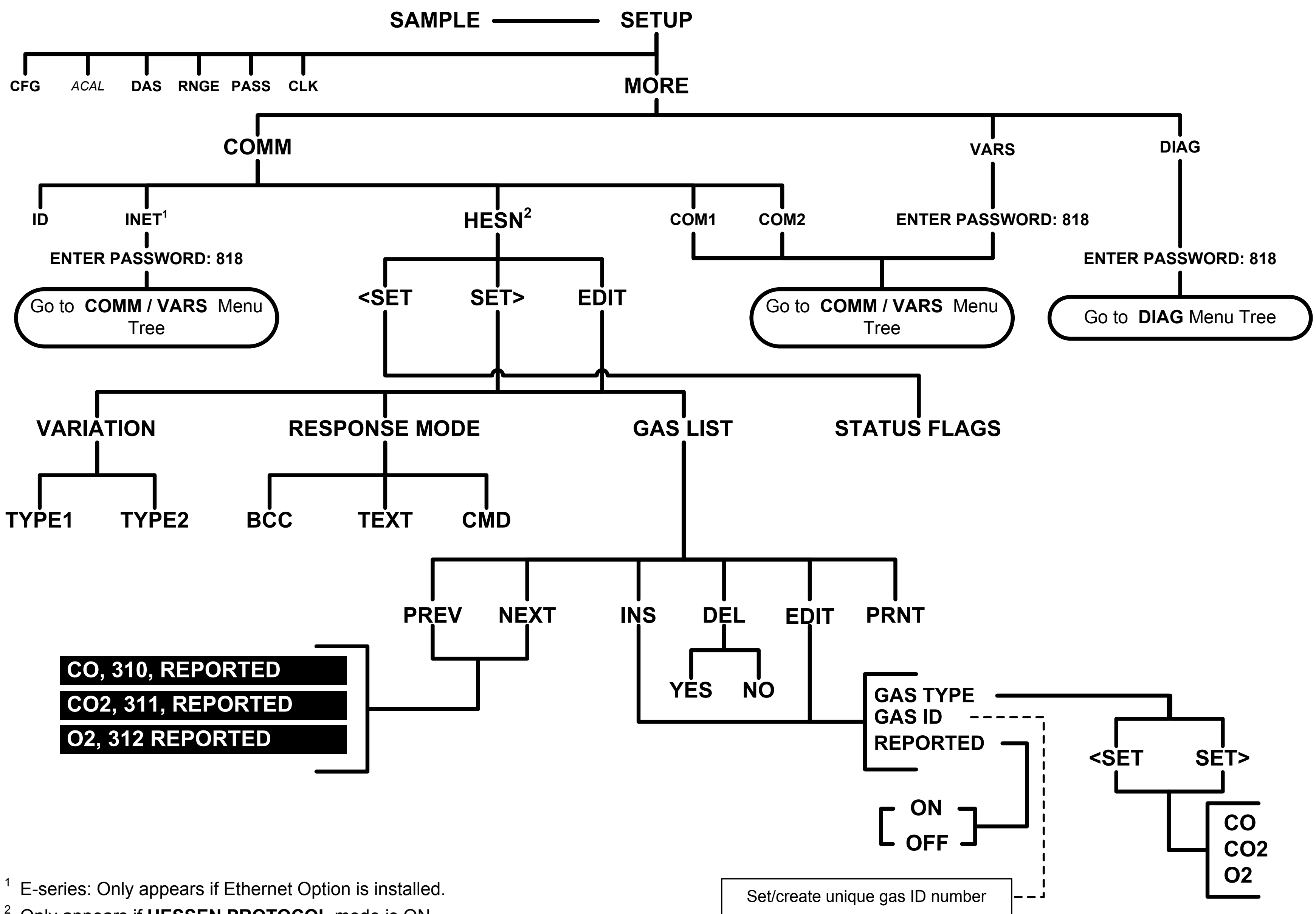
[2] Only appears if **HESSEN PROTOCOL** mode is ON (See **COM1** & **COM2 – MODE** submenu above).

[3] **INSTRUMENT IP**, **GATEWAY IP** & **SUBNET MASK** are only editable when **DHCP** is **OFF**.

[4] Although **TCP PORT** is editable regardless of the **DHCP** state, do not change the setting for this property.

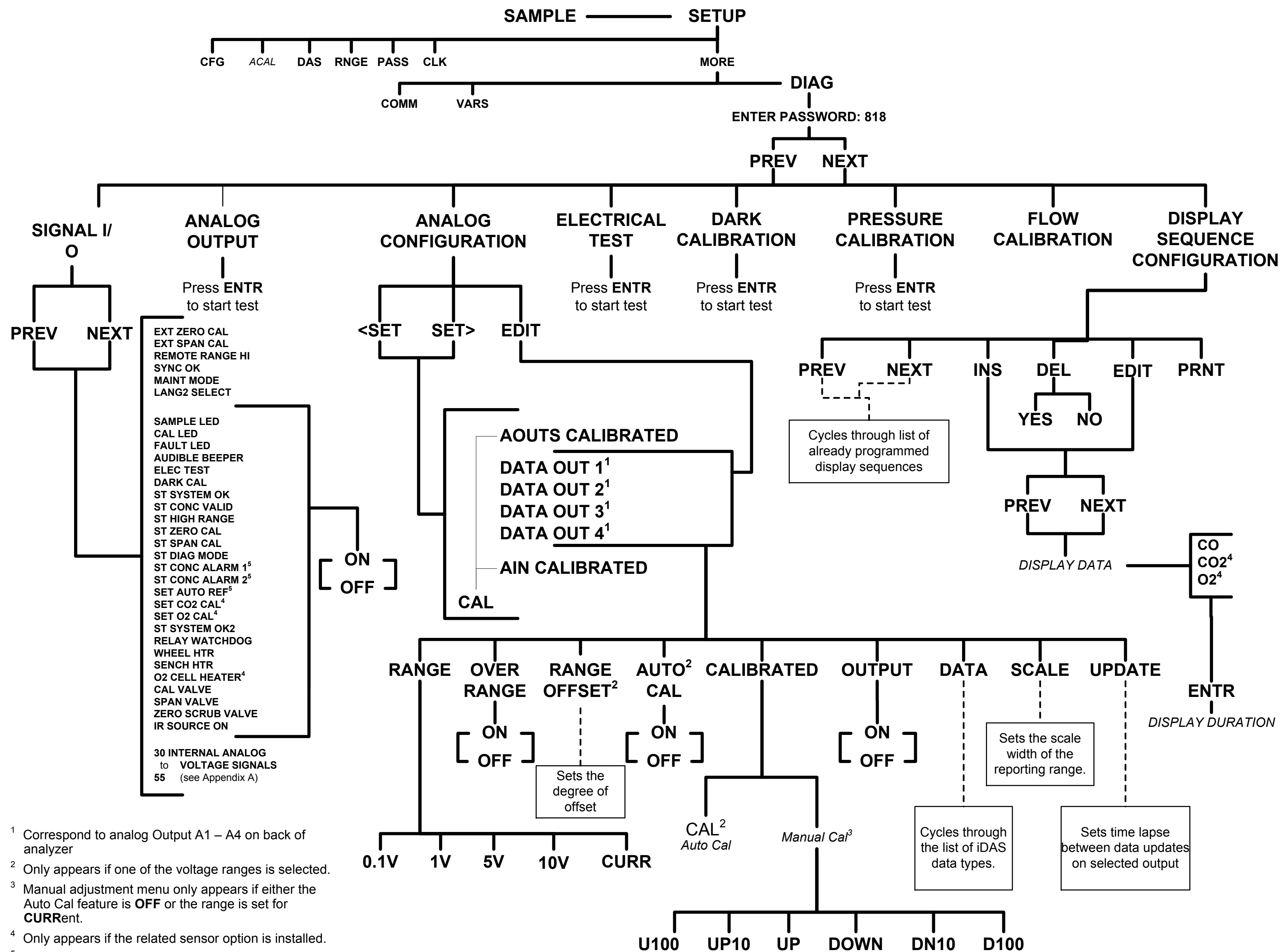
[5] **HOST NAME** is only editable when **DHCP** is **ON**.

Figure A-4: Secondary Setup Menu → COMM and VARS Submenus



[1] E-series: Only appears if Ethernet Option is installed.
[2] Only appears if **HESSEN PROTOCOL** mode is ON.

Figure A-5: Secondary Setup Menu → Hessen Protocol Submenu



[1] Correspond to analog Output A1 – A4 on back of analyzer

[2] Only appears if one of the voltage ranges is selected.

[3] Manual adjustment menu only appears if either the Auto Cal feature is **OFF** or the range is set for **CURR**ent.

[4] Only appears if the related sensor option is installed.

[5] Only appears in T300M and M300EM

Figure A-6: DIAG Menu

APPENDIX A-2: Setup Variables For Serial I/O

Table A-1: T300/T300M and M300E/EM Setup Variables, Revision L.8

Setup Variable	Numeric Units	Default Value	Value Range	Description
Low Access Level Setup Variables (818 password)				
DAS_HOLD_OFF	Minutes	15	0.5–20	Duration of DAS hold off period.
CONC_PRECISION	—	3	AUTO, 0, 1, 2, 3, 4	Number of digits to display to the right of the decimal point for concentrations on the display.
REM_CAL_DURATION [17]	Minutes	20	1–120	Duration of automatic calibration initiated from TAI protocol.
STABIL_GAS	—	CO [0]	CO, CO2 [10], O2 [14]	Selects gas for stability measurement.
DYN_ZERO	—	OFF	ON, OFF	*ON* enables remote dynamic zero calibration; *OFF* disables it.
DYN_SPAN	—	OFF	ON, OFF	*ON* enables remote dynamic span calibration; *OFF* disables it.
CLOCK_ADJ	Sec./Day	0	-60–60	Time-of-day clock speed adjustment.
Medium Access Level Setup Variables (929 password)				
LANGUAGE_SELECT	—	ENGL [0]	ENGL, SECD, EXTN	Selects the language to use for the user interface.
MAINT_TIMEOUT	Hours	2	0.1–100	Time until automatically switching out of software-controlled maintenance mode.
CONV_TIME	—	33 MS [0]	33 MS, 66 MS, 133 MS, 266 MS, 533 MS, 1 SEC, 2 SEC	Conversion time for measure/reference detector channel.
CO_DWELL	Seconds	0.2	0.1–30	Dwell time before taking measure or reference sample.
CO_SAMPLE	Samples	1	1–30	Number of samples to take in measure or reference mode.
PRE_FILT_SIZE [5, 19]	Samples	16	1–50	Moving average pre-filter size.
FILT_SIZE	Samples	750, 720 [9, 12] 200 [3, 8] 1000 [19, 23]	1–1000	Moving average filter size.

Setup Variable	Numeric Units	Default Value	Value Range	Description
FILT_ASIZE	Samples	48, 20 [3, 8], 40 [20, 22]	1–1000	Moving average filter size in adaptive mode.
FILT_DELTA	PPM	4, 0.7 [5] 15 [3, 8] 0.15 [9, 12] 0.4 [19, 23] 0.2 [20, 22]	1–1000	Absolute change to trigger adaptive filter.
FILT_PCT	%	10 5 [20, 22, 23]	1–100	Percent change to trigger adaptive filter.
FILT_DELAY	Seconds	90, 72 [20, 22]	0–180	Delay before leaving adaptive filter mode.
FILT_ADAPT	—	ON	ON, OFF	*ON* enables adaptive filter; *OFF* disables it.
CO2_DWELL [10]	Seconds	0.1	0.1–30	Dwell time before taking each sample.
CO2_FILT_ADAPT [10]	—	ON	ON, OFF	ON enables CO_2 adaptive filter; OFF disables it.
CO2_FILT_SIZE [10]	Samples	48	1–300	CO_2 moving average filter size.
CO2_FILT_ASIZE [10]	Samples	12	1–300	CO_2 moving average filter size in adaptive mode.
CO2_FILT_DELTA [10]	%	2	0.01–10	Absolute CO_2 conc. change to trigger adaptive filter.
CO2_FILT_PCT [10]	%	10	0.1–100	Percent CO_2 conc. change to trigger adaptive filter.
CO2_FILT_DELAY [10]	Seconds	90	0–300	Delay before leaving CO_2 adaptive filter mode.
CO2_DIL_FACTOR [10]	—	1	0.1–1000	Dilution factor for CO_2. Used only if is dilution enabled with *FACTORY_OPT* variable.
O2_DWELL [14]	Seconds	1	0.1–30	Dwell time before taking each sample.
O2_FILT_ADAPT [14]	—	ON	ON, OFF	ON enables O_2 adaptive filter; OFF disables it.
O2_FILT_SIZE [14]	Samples	60	1–500	O_2 moving average filter size in normal mode.
O2_FILT_ASIZE [14]	Samples	10	1–500	O_2 moving average filter size in adaptive mode.
O2_FILT_DELTA [14]	%	2	0.1–100	Absolute change in O_2 concentration to shorten filter.
O2_FILT_PCT [14]	%	2	0.1–100	Relative change in O_2 concentration to shorten filter.
O2_FILT_DELAY [14]	Seconds	20	0–300	Delay before leaving O_2 adaptive filter mode.
O2_DIL_FACTOR [14]	—	1	0.1–1000	Dilution factor for O_2. Used only if is dilution enabled with *FACTORY_OPT* variable.

Setup Variable	Numeric Units	Default Value	Value Range	Description
USER_UNITS	—	PPM [0]	PPB, PPM, UGM, MGM % [4, 5, 9, 18] PPM [3, 8] MGM [3, 8]	Concentration units for user interface.
NEG_CONC_SUPPRESS	—	OFF, ON [17]	OFF, ON	ON pegs negative concentrations at zero; OFF permits negative concentrations
DIL_FACTOR	—	1	0.1–1000	Dilution factor. Used only if is dilution enabled with *FACTORY_OPT* variable.
DARK_CAL_DURATION	Seconds	180, 60 [4]	10–600	Duration of dark cal. First two-thirds is stabilization period; final third is measure period.
DARK_MEAS_MV	mV	0	-1000–1000	Dark offset for measure reading.
DARK_REF_MV	mV	0	-1000–1000	Dark offset for reference reading.
CO2_COMP_ENABLE	—	OFF	ON, OFF	ON enables CO_2 compensation; OFF disables it.
CO2_COMP_CONC	%	0	0–20	CO_2 concentration to compensate for.
SOURCE_DRIFT_ENAB [21]	—	OFF	ON, OFF	ON enables source drift compensation; OFF disables it.
SOURCE_DRIFT [21]	PPB/Day	0	-500–500	Source drift compensation rate of change.
CO_CONST1	—	8000, 500 [15,20,22,23] 78.8 [9,12] 3020 [18] 500 [4,9,12] 39600 [8] 40000 [3]	100–50000	CO calculation constant.
CO_CONST2	—	0.2110 0.356 [20,22,23] 0.367 [15] 1.458 [9,12] 1.4625 [18] 1.448 [4] 0.192 [8] 0.187 [3] 0.1196 [24]	0–10	CO calculation constant.
ET_MEAS_GAIN	—	1	0.0001–9.9999	Electrical test gain factor for measure reading.
ET_REF_GAIN	—	1	0.0001–9.9999	Electrical test gain factor for reference reading.

Setup Variable	Numeric Units	Default Value	Value Range	Description
ET_TARGET_DET	mV	4375	0–5000	Target detector reading during electrical test.
ET_TARGET_CONC	PPM	40, 400 [3, 8]	1–9999.99	Target concentration during electrical test.
ET_CONC_RANGE	Conc.	50, 5000 [3, 8]	0.1–50000	D/A concentration range during electrical test.
STD_TEMP	ºK	321	1–500	Standard temperature for temperature compensation.
STD_PRESS	"Hg	28.5, 28.7 [8], 28.8 [12, 18], 28.1 [4]	1–50	Standard pressure for pressure compensation.
BENCH_SET	ºC	48 Warnings: 43–53	0–100	Optical bench temperature set point and warning limits.
WHEEL_SET	ºC	68, 62 [19,23] Warnings: 63–73, 57–67 [19,23]	0–100	Wheel temperature set point and warning limits.
O2_CELL_SET [14]	ºC	50 Warnings: 45–55	30–70	O_2 sensor cell temperature set point and warning limits.
STD_O2_CELL_TEMP [14]	ºK	323	1–500	Standard O_2 cell temperature for temperature compensation.
ZERO_APPLY_IN_CAL [5]	—	ON	OFF, ON	*ON* applies auto-reference offset and dilution factor during zero/span calibration; *OFF* disables both. (Only applicable if *ZERO_ENABLE* is *ON*.)
ZERO_DWELL [3, 5, 8]	Seconds, Minutes [5]	7, 3 [5]	1–60, 1–30 [5]	Dwell time after closing or opening zero scrubber valve.
ZERO_SAMPLES [3, 5, 8]	Samples	15, 750 [5], 1000 [19]	1–1000	Number of zero samples to average.
ZERO_FILT_SIZE [3, 5, 8]	Samples	5, 1 [5]	1–100	Auto-zero offset moving average filter size.
ZERO_LIMIT [3, 5, 8]	Ratio	1.2, 1.15 [3, 8], 1 [5]	0–5	Minimum auto-zero ratio allowed; must be *greater* than this value to be valid.
ZERO_CAL [3, 5, 8]	Ratio	1.18	0.5–5	Calibrated auto-zero ratio.

Setup Variable	Numeric Units	Default Value	Value Range	Description
CO_TARG_ZERO1	Conc.	0	-100.00–999.99	Target CO concentration during zero offset calibration of range 1.
CO_TARG_MID1_1	Conc.	50 [5], 300	0.01–9999.99	Target CO concentration during mid-point #1 calibration of range 1.
CO_TARG_MID2_1	Conc.	50 [5], 300	0.01–9999.99	Target CO concentration during mid-point #2 calibration of range 1.
CO_SPAN1	Conc.	40, 400 [3, 8]	0.01–9999.99	Target CO concentration during internal span calibration of range 1.
CO_SLOPE1	—	1	0.001–999.999	CO slope for range 1.
CO_OFFSET1	—	0	-10–10	CO offset for range 1.
CAL_BOX_TEMP1	ºC	30	0–100	Calibrated box temperature for range 1.
CO_TARG_ZERO2	Conc.	0	-100.00–999.99	Target CO concentration during zero offset calibration of range 2.
CO_TARG_MID1_2	Conc.	50 [5], 300	0.01–9999.99	Target CO concentration during mid-point #1 calibration of range 2.
CO_TARG_MID2_2	Conc.	50 [5], 300	0.01–9999.99	Target CO concentration during mid-point #2 calibration of range 2.
CO_SPAN2	Conc.	40, 400 [3, 8]	0.01–9999.99	Target CO concentration during internal span calibration of range 2.
CO_SLOPE2	—	1	0.001–999.999	CO slope for range 2.
CO_OFFSET2	—	0	-10–10	CO offset for range 2.
CAL_BOX_TEMP2	ºC	30	0–100	Calibrated box temperature for range 2.
CO2_TARG_MID1_CONC [10]	%	6, 800 [16]	0.1–1000, 0.1–2000 [16]	Target CO_2 concentration during mid-point #1 calibration.
CO2_TARG_MID2_CONC [10]	%	6, 800 [16]	0.1–1000, 0.1–2000 [16]	Target CO_2 concentration during mid-point #2 calibration.
CO2_TARG_SPAN_CONC [10]	%	12	0.1–1000, 0.1–2000 [16]	Target CO_2 concentration during span calibration.
CO2_SLOPE [10]	—	1	0.5–5	CO_2 slope.
CO2_OFFSET [10]	%	0	-10–10, -100–100 [16]	CO_2 offset.
O2_TARG_SPAN_CONC [14]	%	20.95	0.1–100	Target O_2 concentration during span calibration.
O2_SLOPE [14]	—	1	0.5–2	O_2 slope.
O2_OFFSET [14]	%	0	-10–10	O_2 offset.

Setup Variable	Numeric Units	Default Value	Value Range	Description
RANGE_MODE	—	SNGL [0]	SNGL, DUAL, AUTO	Range control mode.
CONC_RANGE1	Conc.	50, 200 [6], 500 [3, 8]	0.1–50000	D/A concentration range 1.
CONC_RANGE2 [1]	Conc.	50, 200 [6], 500 [3, 8]	0.1–50000	D/A concentration range 2.
CO2_RANGE [10]	%	15	0.1–500, 0.1–2000 [16]	CO_2 concentration range.
O2_RANGE [14]	%	100	0.1–500	O_2 concentration range.
RS232_MODE	BitFlag	0	0–65535	RS-232 COM1 mode flags. Add values to combine flags. 1 = quiet mode 2 = computer mode 4 = enable security 8 = enable hardware handshaking 16 = enable Hessen protocol [11] 32 = enable multi-drop 64 = enable modem 128 = ignore RS-232 line errors 256 = disable XON / XOFF support 512 = disable hardware FIFOs 1024 = enable RS-485 mode 2048 = even parity, 7 data bits, 1 stop bit 4096 = enable command prompt 8192 = even parity, 8 data bits, 1 stop bit 16384 = enable dedicated MODBUS ASCII protocol 32678 = enable dedicated MODBUS RTU or TCP protocol 16384 = enable TAI protocol [17]
BAUD_RATE	—	115200 [0]	300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	RS-232 COM1 baud rate.

Setup Variable	Numeric Units	Default Value	Value Range	Description
MODEM_INIT	—	"AT Y0 &D0 &H0 &I0 S0=2 &B0 &N6 &M0 E0 Q1 &W0" [0]	Any character in the allowed character set. Up to 100 characters long.	RS-232 COM1 modem initialization string. Sent verbatim plus carriage return to modem on power up or manually.
RS232_MODE2	BitFlag	0	0–65535	RS-232 COM2 mode flags. *(Same settings as RS232_MODE.)*
BAUD_RATE2	—	19200 [0]	300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	RS-232 COM2 baud rate.
MODEM_INIT2	—	"AT Y0 &D0 &H0 &I0 S0=2 &B0 &N6 &M0 E0 Q1 &W0" [0]	Any character in the allowed character set. Up to 100 characters long.	RS-232 COM2 modem initialization string. Sent verbatim plus carriage return to modem on power up or manually.
RS232_PASS	Password	940331	0–999999	RS-232 log on password.
MACHINE_ID	ID	300, 320 [4]	0–9999	Unique ID number for instrument.
COMMAND_PROMPT	—	"Cmd> " [0]	Any character in the allowed character set. Up to 100 characters long.	RS-232 interface command prompt. Displayed only if enabled with *RS232_MODE* variable.

Setup Variable	Numeric Units	Default Value	Value Range	Description
TEST_CHAN_ID	—	NONE [0]	NONE, CO MEASURE, CO REFERENCE, VACUUM PRESSURE, SAMPLE PRESSURE, SAMPLE FLOW, SAMPLE TEMP, BENCH TEMP, WHEEL TEMP, O2 CELL TEMP [14], CHASSIS TEMP, PHT DRIVE, TEMP4 [5]	Diagnostic analog output ID.
REMOTE_CAL_MODE	—	LOW [0]	LOW, HIGH, CO2 [10], O2 [14]	CO range or other gas to calibrate during contact closure or Hessen calibration.
PASS_ENABLE	—	OFF	ON, OFF	*ON* enables passwords; *OFF* disables them.
STABIL_FREQ	Seconds	10 120 [19, 23]	1–300	Stability measurement sampling frequency.
STABIL_SAMPLES	Samples	25	2–40	Number of samples in concentration stability reading.
PHOTO_TEMP_SET	mV	2500 Warnings: 250–4750	0–5000	Photometer temperature warning limits. Set point is not used.
SAMP_PRESS_SET	In-Hg	29.92 Warnings: 15–32	0–100	Sample pressure warning limits. Set point is not used.

Setup Variable	Numeric Units	Default Value	Value Range	Description
SAMP_FLOW_SET	cc/m	800, 2000 [13] 1800 [5,19] Warnings: 640–960, 1400–2200 [5,19] 1500–2500 [13]	0–5000	Sample flow warning limits. Set point is not used.
SAMP_FLOW_SLOPE	—	1 4.5 [5,19]	0.001–100	Slope term to correct sample flow rate.
VAC_SAMP_RATIO	—	0.53, 0.61 [13]	0.1–2	Maximum vacuum pressure / sample pressure ratio for valid sample flow calculation.
PURGE_PRESS_SET	PSIG	7.5 Warnings: 2.5–12.5	0–100	Purge pressure warning limits. Set point is not used.
SAMP_TEMP_SET	ºC	30 Warnings: 10.1–100	0–100	Sample temperature warning limits. Set point is not used.
BOX_SET	ºC	30 Warnings: 5–48	0–100	Internal box temperature warning limits. Set point is not used.
BOX2_SET [5], OVEN_SET [19,23]	ºC	30 46 [19,23] Warnings: 25–35 41–51 [19,23]	0–100	Internal box temperature #2 / oven set point and warning limits.
BOX2_CYCLE [5], OVEN_CYCLE [19,23]	Seconds	10	0.5–30	Internal box temperature #2/oven control cycle period.
BOX2_PROP [5], OVEN_PROP [19,23]	1/ºC	1 0.5 [19,23]	0–100	Internal box temperature #2/oven PID proportional coefficient. Proportional band is the reciprocal of this setting.
BOX2_INTEG [5], OVEN_INTEG [19,23]	—	0.1 0.02 [19,23]	0–100	Internal box temperature #2/oven PID integral coefficient.
BOX2_DERIV [5], OVEN_DERIV [19,23]	—	0	0–100	Internal box temperature #2/oven PID derivative coefficient.
BENCH_CYCLE	Seconds	2 15 [19,23]	0.5–30	Optical bench temperature control cycle period.
BENCH_PROP	1/ºC	5 1.5 [19,23]	0–100	100V optical bench temperature PID proportional coefficient. Proportional band is the reciprocal of this setting.
BENCH_INTEG	—	0.5 1.5 [19,23]	0–100	100V optical bench temperature PID integral coefficient.

Setup Variable	Numeric Units	Default Value	Value Range	Description
BENCH_DERIV	—	2 0 [19,23]	0–100	100V optical bench temperature PID derivative coefficient.
BENCH_PROP2	1/ºC	5 0.75 [19,23]	0–100	200V optical bench temperature PID proportional coefficient. Proportional band is the reciprocal of this setting.
BENCH_INTEG2	—	0.5 0.75 [19,23]	0–100	200V optical bench temperature PID integral coefficient.
BENCH_DERIV2	—	2 0 [19,23]	0–100	200V optical bench temperature PID derivative coefficient.
WHEEL_CYCLE	Seconds	4 2 [4,9,12,18] 8 [19,23]	0.5–30	Wheel temperature control cycle period.
WHEEL_PROP	1/ºC	1 0.3 [19,23]	0–100	100V wheel temperature PID proportional coefficient. Proportional band is the reciprocal of this setting.
WHEEL_INTEG	—	0.135 0.035 [4,9,12,18] 0.06 [19,23]	0–100	100V wheel temperature PID integral coefficient.
WHEEL_DERIV	—	2 0 [19,23]	0–100	100V wheel temperature PID derivative coefficient.
WHEEL_PROP2	1/ºC	1 0.1 [19,23]	0–100	200V wheel temperature PID proportional coefficient. Proportional band is the reciprocal of this setting.
WHEEL_INTEG2	—	0.135 0.035 [4,9,12,18] 0.01 [19,23]	0–100	200V wheel temperature PID integral coefficient.
WHEEL_DERIV2	—	2 0 [19,23]	0–100	200V wheel temperature PID derivative coefficient.
O2_CELL_CYCLE [14]	Seconds	10	0.5–30	O_2 cell temperature control cycle period.
O2_CELL_PROP [14]	—	1	0–10	O_2 cell PID temperature control proportional coefficient.
O2_CELL_INTEG [14]	—	0.1	0–10	O_2 cell PID temperature control integral coefficient.
O2_CELL_DERIV [14]	—	0 (disabled)	0–10	O_2 cell PID temperature control derivative coefficient.
BOX_TEMP_GAIN	PPB/DegC	0, 5 [9]	0–100	Gain factor for box temperature compensation of concentration.
TPC_ENABLE	—	ON	OFF, ON	*ON* enables temperature/ pressure compensation; *OFF* disables it.
CONC_LIN_ENABLE	—	ON	OFF, ON	*ON* enables concentration linearization; *OFF* disables it.
STAT_REP_PERIOD [17]	Seconds	1	0.5–120	TAI protocol status message report period.

Setup Variable	Numeric Units	Default Value	Value Range	Description
SERIAL_NUMBER	—	"00000000 " [0]	Any character in the allowed character set. Up to 100 characters long.	Unique serial number for instrument.
DISP_INTENSITY	—	HIGH [0]	HIGH, MED, LOW, DIM	Front panel display intensity.
I2C_RESET_ENABLE	—	ON	OFF, ON	*ON* enables automatic reset of the I^2C bus in the event of communication failures; *OFF* disables automatic reset.
CLOCK_FORMAT	—	"TIME=%H:%M:%S"	Any character in the allowed character set. Up to 100 characters long.	Time-of-day clock format flags. Enclose value in double quotes (") when setting from the RS-232 interface. "%a" = Abbreviated weekday name. "%b" = Abbreviated month name. "%d" = Day of month as decimal number (01 – 31). "%H" = Hour in 24-hour format (00 – 23). "%I" = Hour in 12-hour format (01 – 12). "%j" = Day of year as decimal number (001 – 366). "%m" = Month as decimal number (01 – 12). "%M" = Minute as decimal number (00 – 59). "%p" = A.M./P.M. indicator for 12-hour clock. "%S" = Second as decimal number (00 – 59). "%w" = Weekday as decimal number (0 – 6; Sunday is 0). "%y" = Year without century, as decimal number (00 – 99). "%Y" = Year with century, as decimal number. "%%" = Percent sign.
ALARM_TRIGGER [3,4]	Cycles	10	1–100	Concentration alarm trigger sensitivity adjustment.
REF_SDEV_LIMIT	mV	50	0.1–500	Reference detector standard deviation must be below this limit to switch out of startup mode.

Setup Variable	Numeric Units	Default Value	Value Range	Description
REF_SOURCE_LIMIT	mV	3000 (not used) Warnings: 1100–4800, 25–4800 [3, 4, 15]	1–5000	Reference source warning limits. Set point is not used.
FACTORY_OPT	BitFlag	512, 768 [5]	0–65535	Factory option flags. Add values to combine flags. 1 = enable dilution factor 2 = zero/span valves installed 4 = enable conc. alarms 8 = enable linearity adjustment factor 16 = display units in concentration field 32 = enable software-controlled maintenance mode 64 [3, 5] = span valve installed 128 = enable switch-controlled maintenance mode 256 = compute only offset during zero calibration 512 = 220 V A/C power 1024 = non-zero offset calibration (linearity adjustment must also be enabled) 2048 = enable Internet option [7] 4096 = use “old” style numeric data entry menus when editing conc. table 8192 = locate high range and zero cal. status outputs on relays

Setup Variable	Numeric Units	Default Value	Value Range	Description

[0] Enclose value in double quotes (") when setting from the RS-232 interface
[1] Multi-range modes
[2] Hessen protocol
[3] T300H, M300EH
[4] T360, M360E
[5] T300U, M300EU
[6] Fixed range special
[7] iChip option (E-Series)
[8] T300M, M300EM
[9] GFC7000E
[10] CO_2 option
[11] Must power-cycle instrument for these options to take effect
[12] T360U, M360EU
[13] Riken Keiki special
[14] O_2 option
[15] T320, M320E
[16] CO_2 PPM sensor
[17] TAI protocol
[18] T360M, M360EM
[19] T300U2, M300EU2
[20] T320U, M320EU
[21] Source drift compensation option
[22] GFC7002EU
[23] T320U2, M320EU2
[24] N_2O compensation option

APPENDIX A-3: Warnings and Test Functions

Table A-2: T300/T300M and M300E/EM Warning Messages, Revision L.8

Name [1]	Message Text	Description
Warnings		
WSYSRES	SYSTEM RESET	Instrument was power-cycled or the CPU was reset.
WDATAINIT	DATA INITIALIZED	Data storage was erased.
WCONFIGINIT	CONFIG INITIALIZED	Configuration storage was reset to factory configuration or erased.
WCONCALARM1	CONC ALARM 1 WARN	Concentration limit 1 exceeded.
WCONCALARM2	CONC ALARM 2 WARN	Concentration limit 2 exceeded.
WSOURCE	SOURCE WARNING	Reference reading minus dark offset outside of warning limits specified by *REF_SOURCE_LIMIT* variable.
WAUTOZERO [4, 5]	AZERO WARN 1.001	Auto-reference ratio below limit specified by *ZERO_LIMIT* variable.
WBENCHTEMP	BENCH TEMP WARNING	Bench temperature outside of warning limits specified by *BENCH_SET* variable.
WWHEELTEMP	WHEEL TEMP WARNING	Wheel temperature outside of warning limits specified by *WHEEL_SET* variable.
WO2CELLTEMP [10]	O2 CELL TEMP WARN	O_2 sensor cell temperature outside of warning limits specified by *O2_CELL_SET* variable.
WSAMPFLOW [6]	SAMPLE FLOW WARN	Sample flow outside of warning limits specified by *SAMP_FLOW_SET* variable.
WSAMPPRESS	SAMPLE PRESS WARN	Sample pressure outside of warning limits specified by *SAMP_PRESS_SET* variable.
WSAMPTEMP	SAMPLE TEMP WARN	Sample temperature outside of warning limits specified by *SAMP_TEMP_SET* variable.
WPURGEPRESS [9]	PURGE PRESS WARN	Purge pressure outside of warning limits specified by *PURGE_PRESS_SET* variable.
WBOXTEMP	BOX TEMP WARNING	Internal box temperature outside of warning limits specified by *BOX_SET* variable.
WBOXTEMP2 [4]	BOX TEMP2 WARNING	Internal box temperature #2 outside of warning limits specified by *BOX2_SET* variable.
WOVENTEMP [11]	OVEN TEMP WARNING	Oven temperature outside of warning limits specified by *OVEN_SET* variable.
WPHOTOTEMP	PHOTO TEMP WARNING	Photometer temperature outside of warning limits specified by *PHOTO_TEMP_SET* variable.
WDYNZERO	CANNOT DYN ZERO	Contact closure zero calibration failed while *DYN_ZERO* was set to *ON*.
WDYNSPAN	CANNOT DYN SPAN	Contact closure span calibration failed while *DYN_SPAN* was set to *ON*.
WREARBOARD	REAR BOARD NOT DET	Rear board was not detected during power up.

Name [1]	Message Text	Description
WRELAYBOARD	RELAY BOARD WARN	Firmware is unable to communicate with the relay board.
WFRONTPANEL[12]	FRONT PANEL WARN	Firmware is unable to communicate with the front panel.
WANALOGCAL	ANALOG CAL WARNING	The A/D or at least one D/A channel has not been calibrated.

[1] The name is used to request a message via the RS-232 interface, as in “T BOXTEMP”
[2] Engineering software
[3] Current instrument units
[4] T300U, M300EU
[5] T300H, M300EH
[6] Except T360U, M360EU (APR version)
[7] T360, M360E
[8] Sample pressure or differential pressure flow measurement option
[9] GFC7000E
[10] O_2 option
[11] T300U2, T320U2, M300EU2, M320EU2
[12] Applies to E-Series only

Table A-3: T300/T300M and M300E/EM Test Functions, Revision L.8

TEST FUNCTION NAME	MESSAGE TEXT	DESCRIPTION
RANGE	RANGE=50.0 PPM [3] CO RANGE=50.0 PPM [3, 7]	D/A range in single or auto-range modes.
RANGE1	RANGE1=50.0 PPM [3] CO RANGE1=50.0 PPM [3, 7]	D/A #1 range in dual range mode.
RANGE2	RANGE2=50.0 PPM [3] CO RANGE2=50.0 PPM [3, 7]	D/A #2 range in dual range mode.
CO2RANGE	CO2 RANGE=20 % [7]	CO_2 range.
O2RANGE	O2 RANGE=100 % [10]	O_2 range.
STABILITY	STABIL=0.0 PPM [3] CO STB=0.0 PPM [3, 7, 10] CO2 STB=0.0 % [7] O2 STB=0.0 % [10]	Concentration stability (standard deviation based on setting of *STABIL_FREQ* and *STABIL_SAMPLES*).
RESPONSE [2]	RSP=0.20(0.00) SEC	Instrument response. Length of each signal processing loop. Time in parenthesis is standard deviation.
COMEAS	CO MEAS=4125.0 MV	Detector measure reading.
COREF	CO REF=3750.0 MV	Detector reference reading.
MRRATIO	MR RATIO=1.100	Measure/reference ratio.
AUTOZERO [4, 5]	AZERO RATIO=1.234	Measure/reference ratio during auto-reference.
SAMPPRESS	PRES=29.9 IN-HG-A	Sample pressure.
PURGEPRESS [9]	PURGE=7.5 PSIG	Purge pressure
VACUUM [8]	VAC=6.8 IN-HG-A	Vacuum pressure.
SAMPFLOW [6]	SAMP FL=751 CC/M	Sample flow rate.
SAMPTEMP	SAMPLE TEMP=26.8 C	Sample temperature.
BENCHTEMP	BENCH TEMP=48.1 C	Bench temperature.
WHEELTEMP	WHEEL TEMP=68.1 C	Wheel temperature.
O2CELLTEMP [10]	O2 CELL TEMP=50.2 C	O_2 sensor cell temperature.
BOXTEMP	BOX TEMP=26.8 C	Internal box temperature.
BOXTEMP2 [4]	BOX TEMP2=29.6 C	Internal box temperature #2.
OVENTEMP [11]	OVEN TEMP=30.1 C	Oven temperature
PHOTOTEMP	PHT DRIVE=2500.0 MV	Photometer temperature.
COSLOPE	SLOPE=1.000 CO SLOPE=1.000 [7]	CO slope for current range, computed during zero/span calibration.
COSLOPE1	SLOPE1=1.000 CO SLOPE1=1.000 [7]	CO slope for range #1 in dual range mode, computed during zero/span calibration.
COSLOPE2	SLOPE2=1.000 CO SLOPE2=1.000 [7]	CO slope for range #2 in dual range mode, computed during zero/span calibration.
COOFFSET	OFFSET=0.000 CO OFFSET=0.000 [7]	CO offset for current range, computed during zero/span calibration.
COOFFSET1	OFFSET1=0.000 CO OFFSET1=0.000 [7]	CO offset for range #1 in dual range mode, computed during zero/span calibration.

TEST FUNCTION NAME	MESSAGE TEXT	DESCRIPTION
COOFFSET2	OFFSET2=0.000 CO OFFSET2=0.000 [7]	CO offset for range #2 in dual range mode, computed during zero/span calibration.
CO2SLOPE [7]	CO2 SLOPE=1.000	CO_2 slope, computed during zero/span calibration.
CO2OFFSET [7]	CO2 OFFSET=0.000	CO_2 offset, computed during zero/span calibration.
O2SLOPE [10]	O2 SLOPE=0.980	O_2 slope, computed during zero/span calibration.
O2OFFSET [10]	O2 OFFSET=1.79 %	O_2 offset, computed during zero/span calibration.
CO	CO=17.7 PPM [3]	CO concentration for current range.
CO2 [7]	CO2=15.0 %	CO_2 concentration.
O2 [10]	O2=0.00 %	O_2 concentration.
TESTCHAN	TEST=1751.4 MV	Value output to *TEST_OUTPUT* analog output, selected with *TEST_CHAN_ID* variable.
CLOCKTIME	TIME=09:52:20	Current instrument time of day clock.
RANGE(s)	User Configurable	
CO2RANGE	CO2 RANGE=20 % [1]	CO_2 range.
O2RANGE	O2 RANGE=100 % [2]	O_2 range.
STABILITY	STABIL=0.0 PPM CO STB=0.0 PPM [1, 2] CO2 STB=0.0 % [1] O2 STB=0.0 % [2]	Concentration stability (standard deviation based on setting of *STABIL_FREQ* and *STABIL_SAMPLES*).
COMEAS	CO MEAS=4125.0 MV	Detector measure reading.
COREF	CO REF=3750.0 MV	Detector reference reading.
MRRATIO	MR RATIO=1.100	Measure/reference ratio.
SAMPPRESS	PRES=29.9 IN-HG-A	Sample pressure.
SAMPFLOW	SAMP FL=751 CC/M	Sample flow rate.
SAMPTEMP	SAMPLE TEMP=26.8 C	Sample temperature.
BENCHTEMP	BENCH TEMP=48.1 C	Bench temperature.
WHEELTEMP	WHEEL TEMP=68.1 C	Wheel temperature.
O2CELLTEMP [2]	O2 CELL TEMP=50.2 C	O_2 sensor cell temperature.
BOXTEMP	BOX TEMP=26.8 C	Internal chassis temperature.
PHOTOTEMP	PHT DRIVE=2500.0 MV	Photometer temperature.
COSLOPE	SLOPE=1.000 CO SLOPE=1.000 [1]	CO slope for current range, computed during zero/span calibration.
COSLOPE1	SLOPE1=1.000 CO SLOPE1=1.000 [1]	CO slope for range #1 in dual range mode, computed during zero/span calibration.
COSLOPE2	SLOPE2=1.000 CO SLOPE2=1.000 [1]	CO slope for range #2 in dual range mode, computed during zero/span calibration.
COOFFSET	OFFSET=0.000 CO OFFSET=0.000 [1]	CO offset for current range, computed during zero/span calibration.
COOFFSET1	OFFSET1=0.000 CO OFFSET1=0.000 [1]	CO offset for range #1 in dual range mode, computed during zero/span calibration.
COOFFSET2	OFFSET2=0.000 CO OFFSET2=0.000 [1]	CO offset for range #2 in dual range mode, computed during zero/span calibration.
CO2SLOPE [1]	CO2 SLOPE=1.000	CO_2 slope, computed during zero/span calibration.
CO2OFFSET [1]	CO2 OFFSET=0.000	CO_2 offset, computed during zero/span calibration.

TEST FUNCTION NAME	MESSAGE TEXT	DESCRIPTION
O2SLOPE [2]	O2 SLOPE=0.980	O_2 slope, computed during zero/span calibration.
O2OFFSET [2]	O2 OFFSET=1.79 %	O_2 offset, computed during zero/span calibration.
CO	CO=17.7 PPM	CO concentration for current range.
CO2 [1]	CO2=15.0 %	CO_2 concentration.
O2 [2]	O2=0.00 WT%	O_2 concentration.
TESTCHAN	TEST=1751.4 MV	Value output to *TEST_OUTPUT* analog output, selected with *TEST_CHAN_ID* variable.
CLOCKTIME	TIME=09:52:20	Current instrument time of day clock.

1 The name is used to request a message via the RS-232 interface, as in “T BOXTEMP”
2 Engineering software
3 Current instrument units
4 T300U, M300EU
5 T300H, M300EH
6 Except T360U, M360EU (APR version)
7 T360, M360E
8 Sample pressure or differential pressure flow measurement option
9 GFC7000E
10 O_2 option
11 T300U2, T320U2, M300EU2, M320EU2

APPENDIX A-4: Signal I/O Definitions

Table A-4: Signal I/O Definitions for T300/T300M and M300E/EM Series Analyzers, Revision L.8

Signal Name	Bit or Channel Number	Description
Internal inputs, U7, J108, pins 9–16 = bits 0–7, default I/O address 322 hex		
SYNC_OK	0	1 = sync. OK 0 = sync. error
	1–7	Spare
Internal outputs, U8, J108, pins 1–8 = bits 0–7, default I/O address 322 hex		
ELEC_TEST	0	1 = electrical test on 0 = off
DARK_CAL	1	1 = dark calibration on 0 = off
	2–5	Spare
I2C_RESET	6	1 = reset I2C peripherals 0 = normal
I2C_DRV_RST	7	0 = hardware reset 8584 chip 1 = normal
Control inputs, U11, J1004, pins 1–6 = bits 0–5, default I/O address 321 hex		
EXT_ZERO_CAL	0	0 = go into zero calibration 1 = exit zero calibration
EXT_SPAN_CAL	1	0 = go into span calibration 1 = exit span calibration
REMOTE_RANGE_HI	2	0 = select high range during contact closure calibration 1 = select low range
	3–5	Spare
	6–7	Always 1
Control inputs, U14, J1006, pins 1–6 = bits 0–5, default I/O address 325 hex		
	0–5	Spare
	6–7	Always 1
Control outputs, U17, J1008, pins 1–8 = bits 0–7, default I/O address 321 hex		
	0–7	Spare
Control outputs, U21, J1008, pins 9–12 = bits 0–3, default I/O address 325 hex		
	0–3	Spare

Signal Name	Bit or Channel Number	Description
Alarm outputs, U21, J1009, pins 1–12 = bits 4–7, default I/O address 325 hex		
ST_SYSTEM_OK2	4	1 = system OK 0 = any alarm condition or in diagnostics mode
ST_CONC_ALARM_1 [8]	5	1 = conc. limit 1 exceeded 0 = conc. OK
ST_HIGH_RANGE [10 + 13]	5	1 = high auto-range in use 0 = low auto-range
ST_CONC_ALARM_2 [8]	6	1 = conc. limit 2 exceeded 0 = conc. OK
ST_ZERO_CAL [10 + 13]	6	1 = in zero calibration 0 = not in zero
ST_HIGH_RANGE2 [16]	7	1 = high auto-range in use (mirrors ST_HIGH_RANGE status output) 0 = low auto-range
A status outputs, U24, J1017, pins 1–8 = bits 0–7, default I/O address 323 hex		
ST_SYSTEM_OK	0	0 = system OK 1 = any alarm condition
ST_CONC_VALID	1	0 = conc. valid 1 = hold off or other conditions
ST_HIGH_RANGE	2	0 = high auto-range in use 1 = low auto-range
ST_ZERO_CAL	3	0 = in zero calibration 1 = not in zero
ST_SPAN_CAL	4	0 = in span calibration 1 = not in span
ST_DIAG_MODE	5	0 = in diagnostic mode 1 = not in diagnostic mode
ST_AUTO_REF [3]	6	0 = in auto-reference mode 1 = not in auto-reference mode
	7	Spare
B status outputs, U27, J1018, pins 1–8 = bits 0–7, default I/O address 324 hex		
ST_AUTO_REF [2]	0	0 = in auto-reference mode 1 = not in auto-reference mode
	1–5	Spare
ST_CO2_CAL [7]	6	0 = in CO_2 calibration 1 = not in CO_2 calibration
ST_O2_CAL [5]	7	0 = in O_2 calibration 1 = not in O_2 calibration

Signal Name	Bit or Channel Number	Description
Front panel I^2C keyboard, default I^2C address 4E hex		
MAINT_MODE	5 (input)	0 = maintenance mode 1 = normal mode
LANG2_SELECT	6 (input)	0 = select second language 1 = select first language (English)
SAMPLE_LED	8 (output)	0 = sample LED on 1 = off
CAL_LED	9 (output)	0 = cal. LED on 1 = off
FAULT_LED	10 (output)	0 = fault LED on 1 = off
AUDIBLE_BEEPER	14 (output)	0 = beeper on (for diagnostic testing only) 1 = off
Relay board digital output (PCF8574), default I^2C address 44 hex		
RELAY_WATCHDOG	0	Alternate between 0 and 1 at least every 5 seconds to keep relay board active
WHEEL_HTR	1	0 = wheel heater on 1 = off
BENCH_HTR	2	0 = optical bench heater on 1 = off
O2_CELL_HEATER [5]	3	0 = O_2 sensor cell heater on 1 = off
BOX2_HEATER [3], OVEN_HEATER [15]	3	0 = internal box temperature #2/oven heater on 1 = off
CAL_VALVE	4	0 = let cal. gas in 1 = let sample gas in
SPAN_VALVE	5	0 = let span gas in 1 = let zero gas in
ZERO_SCRUB_VALVE [2,3]	6	0 = open zero scrubber valve 1 = close
SHUTOFF_VALVE	6 7 [3,15]	0 = energize shutoff valve 1 = de-energize
IR_SOURCE_ON	7 n/a [3,15]	0 = IR source on 1 = off

Signal Name	Bit or Channel Number	Description
Rear board primary MUX analog inputs		
SAMPLE_PRESSURE	0	Sample pressure
VACUUM_PRESSURE [6]	1	Vacuum pressure
PURGE_PRESSURE [9, 10]	1	Purge pressure
CO_MEASURE	2	Detector measure reading
CO_REFERENCE	3	Detector reference reading
	4	Temperature MUX
SAMPLE_FLOW	5	Sample flow
PHOTO_TEMP	6	Photometer detector temperature
TEST_INPUT_7	7	Diagnostic test input
TEST_INPUT_8	8	Diagnostic test input
REF_4096_MV	9	4.096V reference from MAX6241
O2_SENSOR [5]	10	O_2 concentration sensor
	11	Spare
CO2_SENSOR [7]	12	CO_2 concentration sensor
	13	Spare
	14	DAC loopback MUX
REF_GND	15	Ground reference
Rear board temperature MUX analog inputs		
BOX_TEMP	0	Internal box temperature
SAMPLE_TEMP	1	Sample temperature
BENCH_TEMP	2	Optical bench temperature
WHEEL_TEMP	3	Wheel temperature
TEMP_INPUT_4	4	Diagnostic temperature input
TEMP_INPUT_5	5	Diagnostic temperature input
O2_CELL_TEMP [5]	6	O_2 sensor cell temperature
BOX2_TEMP [3] OVEN_TEMP [19,23]	6	Internal box temperature #2 / oven temperature
	7	Spare
Rear board DAC MUX analog inputs		
DAC_CHAN_1	0	DAC channel 0 loopback
DAC_CHAN_2	1	DAC channel 1 loopback
DAC_CHAN_3	2	DAC channel 2 loopback
DAC_CHAN_4	3	DAC channel 3 loopback

Signal Name	Bit or Channel Number	Description
Rear board analog outputs		
CONC_OUT_1, DATA_OUT_1	0	Concentration output #1 (CO, range #1), Data output #1
CONC_OUT_2, DATA_OUT_2	1	Concentration output #2 (CO, range #2), Data output #2
CONC_OUT_3, [7, 5] DATA_OUT_3	2	Concentration output #3 (CO_2 or O_2), Data output #3
TEST_OUTPUT, DATA_OUT_4	3	Test measurement output, Data output #4

[1] Hessen protocol
[2] T300H, M300EH
[3] T300U, M300EU
[4] T320, M320E
[5] O_2 option
[6] Sample pressure or differential pressure flow measurement option
[7] CO_2 option
[8] Concentration alarms option
[9] T360, M360E
[10] GFC7000E
[11] T300M, M300EM
[13] Air Products special #1
[14] Air Products special #2
[15] T300U2, M300EU2
[16] High auto range relay option

APPENDIX A-5: DAS Triggers and Parameters

Table A-5: T300/T300M and M300E/EM DAS Trigger Events, Revision L.8

Name	Description
ATIMER	Automatic timer expired
EXITZR	Exit zero calibration mode
EXITSP	Exit span calibration mode
EXITMP	Exit multi-point calibration mode
EXITC2 [5]	Exit CO_2 calibration mode
SLPCHG	Slope and offset recalculated
CO2SLC [5]	CO_2 slope and offset recalculated
O2SLPC [7]	O_2 slope and offset recalculated
EXITDG	Exit diagnostic mode
SOURCW	Source warning
AZEROW [1, 2]	Auto-zero warning
CONCW1 [1, 3, 4]	Concentration limit 1 exceeded
CONCW2 [1, 3, 4]	Concentration limit 2 exceeded
SYNCW	Sync warning
BNTMPW	Bench temperature warning
WTEMPW	Wheel temperature warning
O2TMPW [7]	O_2 sensor cell temperature warning
STEMPW	Sample temperature warning
SFLOWW [6]	Sample flow warning
SPRESW	Sample pressure warning
PPRESW [4]	Purge pressure warning
BTEMPW	Internal box temperature warning
BTMP2W [2], OVTMPW [8]	Internal box temperature #2/oven warning
PTEMPW	Photometer detector temperature warning

[1] T300H, M300EH
[2] T300U, M300EU
[3] T320, M320E
[4] GFC7000E
[5] T360, M360E
[6] Except M360EU (APR version)
[7] O_2 option
[8] T300U2, T320U2, M300EU2, M320EU2

Table A-6: T300/T300M and M300E/EM DAS Parameters, Revision L.8

Name	Description	Units
DETMES	Detector measure reading	mV
DETREF	Detector reference reading	mV
RATIO	M/R ratio.	none
SLOPE1	Slope for range #1	none
SLOPE2	Slope for range #2	none
OFSET1	Offset for range #1	none
OFSET2	Offset for range #2	none
CO2SLP [5]	CO_2 slope	none
CO2OFS [5]	CO_2 offset	%
O2SLPE [8]	O_2 slope	none
O2OFST [8]	O_2 offset	%
AZERO [1,2]	Auto-zero reading	M/R
ZSCNC1	Concentration for range #1 during zero/span calibration, just before computing new slope and offset	PPM
ZSCNC2	Concentration for range #2 during zero/span calibration, just before computing new slope and offset	PPM
CO2ZSC [5]	CO_2 concentration during zero/span calibration, just before computing new slope and offset	%
O2ZSCN [8]	O_2 concentration during zero/span calibration, just before computing new slope and offset	%
CONC1	Concentration for range #1	PPM
CONC2	Concentration for range #2	PPM
CO2CNC [5]	CO_2 concentration	%
O2CONC [8]	O_2 concentration	%
STABIL	Concentration stability	PPM
BNTEMP	Bench temperature	°C
BNCDTY	Bench temperature control duty cycle	Fraction (0.0 = off, 1.0 = on full)
WTEMP	Wheel temperature	°C
WHLDTY	Wheel temperature control duty cycle	Fraction (0.0 = off, 1.0 = on full)
O2TEMP [8]	O_2 sensor cell temperature	°C
SMPTMP	Sample temperature	°C
SMPFLW [6]	Sample flow	cc/m
SMPPRS	Sample pressure	"Hg
VACUUM [1, 3, 6]	Vacuum pressure	"Hg
PRGPRS [4]	Purge pressure	PSIG
BOXTMP	Internal box temperature	°C
BX2TMP [2], OVNTMP [9]	Internal box temperature #2/oven	°C

Name	Description	Units
BX2DTY[2], OVNDTY[9]	Internal box temperature #2/oven control duty cycle	Fraction (0.0 = off, 1.0 = on full)
PHTDRV	Photometer detector temperature drive	mV
TEST7	Diagnostic test input (TEST_INPUT_7)	mV
TEST8	Diagnostic test input (TEST_INPUT_8)	mV
TEMP4	Diagnostic temperature input (TEMP_INPUT_4)	°C
TEMP5	Diagnostic temperature input (TEMP_INPUT_5)	°C
REFGND	Ground reference (REF_GND)	mV
RF4096	4096 mV reference (REF_4096_MV)	mV
XIN1[4]	Channel 1 Analog In	
XIN1SLPE[4]	Channel 1 Analog In Slope	
XIN1OFST[4]	Channel 1 Analog In Offset	
XIN2[4]	Channel 2 Analog In	
XIN2SLPE[4]	Channel 2 Analog In Slope	
XIN2OFST[4]	Channel 2 Analog In Offset	
XIN3[4]	Channel 3 Analog In	
XIN3SLPE[4]	Channel 3 Analog In Slope	
XIN3OFST[4]	Channel 3 Analog In Offset	
XIN4[4]	Channel 4 Analog In	
XIN4SLPE[4]	Channel 4 Analog In Slope	
XIN4OFST[4]	Channel 4 Analog In Offset	
XIN5[4]	Channel 5 Analog In	
XIN5SLPE[4]	Channel 5 Analog In Slope	
XIN5OFST[4]	Channel 5 Analog In Offset	
XIN6[4]	Channel 6 Analog In	
XIN6SLPE[4]	Channel 6 Analog In Slope	
XIN6OFST[4]	Channel 6 Analog In Offset	
XIN7[4]	Channel 7 Analog In	
XIN7SLPE[4]	Channel 7 Analog In Slope	
XIN7OFST[4]	Channel 7 Analog In Offset	
XIN8[4]	Channel 8 Analog In	
XIN8SLPE[4]	Channel 8 Analog In Slope	
XIN8OFST[4]	Channel 8 Analog In Offset	

[1] T300H, M300EH
[2] T300U, M300EU
[3] T320, M320E
[4] GFC7000E
[5] T360, M360E
[6] Except T360U, M360EU (APR version)
[7] The units, including the concentration units, are always fixed, regardless of the current instrument units
[8] O_2 option
[9] T300U2, T320U2, M300EU2, M320EU2

APPENDIX A-6: Terminal Command Designators

Table A-7: Terminal Command Designators

COMMAND	ADDITIONAL COMMAND SYNTAX	DESCRIPTION
? [ID]		Display help screen and commands list
LOGON [ID]	password	Establish connection to instrument
LOGOFF [ID]		Terminate connection to instrument
T [ID]	SET ALL|name|hexmask	Display test(s)
	LIST [ALL|name|hexmask] [NAMES|HEX]	Print test(s) to screen
	name	Print single test
	CLEAR ALL|name|hexmask	Disable test(s)
W [ID]	SET ALL|name|hexmask	Display warning(s)
	LIST [ALL|name|hexmask] [NAMES|HEX]	Print warning(s)
	name	Clear single warning
	CLEAR ALL|name|hexmask	Clear warning(s)
C [ID]	ZERO|LOWSPAN|SPAN [1|2]	Enter calibration mode
	ASEQ number	Execute automatic sequence
	COMPUTE ZERO|SPAN	Compute new slope/offset
	EXIT	Exit calibration mode
	ABORT	Abort calibration sequence
D [ID]	LIST	Print all I/O signals
	name[=value]	Examine or set I/O signal
	LIST NAMES	Print names of all diagnostic tests
	ENTER name	Execute diagnostic test
	EXIT	Exit diagnostic test
	RESET [DATA] [CONFIG] [exitcode]	Reset instrument
	PRINT ["name"] [SCRIPT]	Print DAS configuration
	RECORDS ["name"]	Print number of DAS records
	REPORT ["name"] [RECORDS=number] [FROM=<start date>][TO=<end date>][VERBOSE|COMPACT|HEX] (Print DAS records)(date format: MM/DD/YYYY(or YY) [HH:MM:SS]	Print DAS records
	CANCEL	Halt printing DAS records
V [ID]	LIST	Print setup variables
	name[=value [warn_low [warn_high]]]	Modify variable
	name="value"	Modify enumerated variable
	CONFIG	Print instrument configuration
	MAINT ON|OFF	Enter/exit maintenance mode
	MODE	Print current instrument mode
	DASBEGIN [<data channel definitions>] DASEND	Upload DAS configuration
	CHANNELBEGIN propertylist CHANNELEND	Upload single DAS channel
	CHANNELDELETE ["name"]	Delete DAS channels

The command syntax follows the command type, separated by a space character. Strings in [brackets] are optional designators. The following key assignments also apply.

Table A-8: Terminal Key Assignments

TERMINAL KEY ASSIGNMENTS	
ESC	Abort line
CR (ENTER)	Execute command
Ctrl-C	Switch to computer mode
COMPUTER MODE KEY ASSIGNMENTS	
LF (line feed)	Execute command
Ctrl-T	Switch to terminal mode

APPENDIX A-7: MODBUS Register Map

Table A-9: MODBUS Register Map

MODBUS Register Address (dec., 0-based)	Description	Units
MODBUS Floating Point Input Registers (32-bit IEEE 754 format; read in high-word, low-word order; read-only)		
0	Detector measure reading	mV
2	Detector reference reading	mV
4	M/R ratio.	none
6	Slope for range #1	none
8	Slope for range #2	none
10	Offset for range #1	none
12	Offset for range #2	none
14	Concentration for range #1 during zero/span calibration, just before computing new slope and offset	PPM
16	Concentration for range #2 during zero/span calibration, just before computing new slope and offset	PPM
18	Concentration for range #1	PPM
20	Concentration for range #2	PPM
22	Concentration stability	PPM
24	Bench temperature	°C
26	Bench temperature control duty cycle	Fraction (0.0 = off, 1.0 = on full)
28	Wheel temperature	°C
30	Wheel temperature control duty cycle	Fraction (0.0 = off, 1.0 = on full)
32	Sample temperature	°C
34	Sample pressure	“Hg
36	Internal box temperature	°C
38	Photometer detector temperature drive	mV

MODBUS Register Address (dec., 0-based)	Description	Units
40	Diagnostic test input (TEST_INPUT_7)	mV
42	Diagnostic test input (TEST_INPUT_8)	mV
44	Diagnostic temperature input (TEMP_INPUT_4)	°C
46	Diagnostic temperature input (TEMP_INPUT_5)	°C
48	Ground reference (REF_GND)	mV
50	4096 mV reference (REF_4096_MV)	mV
52 [1]	Purge pressure	PSIG
54 [1]	Sample flow	cc/m
56 [1]	Vacuum pressure	"Hg
58 [1]	Internal box temperature #2/oven	°C
60 [1]	Internal box temperature #2/oven control duty cycle	Fraction (0.0 = off, 1.0 = on full)
62 [1]	Auto-zero reading	M/R
100 [2]	O_2 concentration	%
102 [2]	O_2 concentration during zero/span calibration, just before computing new slope and offset	%
104 [2]	O_2 slope	—
106 [2]	O_2 offset	%
108 [2]	O_2 sensor cell temperature	°C
200 [3]	CO_2 concentration	%
202 [3]	CO_2 concentration during zero/span calibration, just before computing new slope and offset	%
204 [3]	CO_2 slope	—
206 [3]	CO_2 offset	%
MODBUS Floating Point Holding Registers (32-bit IEEE 754 format; read/write in high-word, low-word order; read/write)		
0	Maps to *CO_SPAN1* variable; target conc. for range #1	Conc. units
2	Maps to *CO_SPAN2* variable; target conc. for range #2	Conc. units
100 [2]	Maps to *O2_TARG_SPAN_CONC* variable	%
200 [3]	Maps to *CO2_TARG_SPAN_CONC* variable	%

MODBUS Register Address (dec., 0-based)	Description	Units
MODBUS Discrete Input Registers (single-bit; read-only)		
0	Source warning	
1	Box temperature warning	
2	Bench temperature warning	
3	Wheel temperature warning	
4	Sample temperature warning	
5	Sample pressure warning	
6	Photometer detector temperature warning	
7	System reset warning	
8	Rear board communication warning	
9	Relay board communication warning	
10	Front panel communication warning	
11	Analog calibration warning	
12	Dynamic zero warning	
13	Dynamic span warning	
14	Invalid concentration	
15	In zero calibration mode	
16	In span calibration mode	
17	In multi-point calibration mode	
18	System is OK (same meaning as *SYSTEM_OK* I/O signal)	
19 [1]	Purge pressure warning	
20 [1]	Sample flow warning	
21 [1]	Internal box temperature #2/oven warning	
22 [1]	Concentration limit 1 exceeded	
23 [1]	Concentration limit 2 exceeded	
24 [1]	Auto-zero warning	
25 [1]	Sync warning	
26 [1]	In Hessen manual mode	
100 [2]	In O_2 calibration mode	
101 [2]	O_2 cell temperature warning	
102 [1,2]	O_2 concentration limit 1 exceeded	
103 [1,2]	O_2 concentration limit 2 exceeded	
200 [3]	In CO_2 calibration mode	
201 [1,3]	CO_2 concentration limit 1 exceeded	
202 [1,3]	CO_2 concentration limit 2 exceeded	

MODBUS Register Address (dec., 0-based)	Description	Units
MODBUS Coil Registers (single-bit; read/write)		
0	Maps to relay output signal 36 (*MB_RELAY_36* in signal I/O list)	
1	Maps to relay output signal 37 (*MB_RELAY_37* in signal I/O list)	
2	Maps to relay output signal 38 (*MB_RELAY_38* in signal I/O list)	
3	Maps to relay output signal 39 (*MB_RELAY_39* in signal I/O list)	
20 [4]	Triggers zero calibration of range #1 (on enters cal.; off exits cal.)	
21 [4]	Triggers span calibration of range #1 (on enters cal.; off exits cal.)	
22 [4]	Triggers zero calibration of range #2 (on enters cal.; off exits cal.)	
23 [4]	Triggers span calibration of range #2 (on enters cal.; off exits cal.)	

[1] Optional

[2] O_2 option

[3] CO_2 option

[4] Set *DYN_ZERO* or *DYN_SPAN* variables to *ON* to enable calculating new slope or offset. Otherwise a calibration check is performed.

APPENDIX B - Spare Parts

Note	**Use of replacement parts other than those supplied by Teledyne Advanced Pollution Instrumentation (TAPI) may result in non-compliance with European standard EN 61010-1.**

Note	**Due to the dynamic nature of part numbers, please refer to the TAPI Website at http://www.teledyne-api.com or call Customer Service at 800-324-5190 for more recent updates to part numbers.**

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M300E Spare Parts List

(Reference: 05362J DCN5494)

Part Number	Description
000940600	ORIFICE, 10 MIL, SPAN GAS FLOW CONTROL
000940700	ORIFICE, 5 MIL, FLOW CONTROL, 02 OPTION
000941000	ORIFICE, 13 MIL (SAMPLE FLOW)
001760400	ASSY, FLOW CTL, 800CC, 1/4" CONN-B
001761300	ASSY, SPAN GAS FLOW CONTROL
001763000	ASSY, FLOW CTL, 110CC, 1/8" -B
003291500	ASSY, THERMISTOR, BENCH/WHEEL, M300E
006110200	ASSY, M300 MOTOR WHEEL HEATER
009450300	ASSY, ZERO/SPAN VALVES, M300E
009550400	ASSY, SOURCE, M300E S/N<65
009550500	ASSY, SOURCE, M300E S/N>65
009560301	FILTER WHEEL, CO
009600400	AKIT, EXPENDABLES, M300E
009690000	AKIT, TFE FLTR ELEM, FL6, 47MM (100=1)
009690100	AKIT, TFE FLTR, 47MM, (FL6, 30=1)
009840300	ASSY, SHUT-OFF VALVE W/FLOW CONTROL
010790000	INPUT MIRROR, REPLICATED(KB)
010800000	OUTPUT MIRROR, REPLICATED(KB)
016290000	WINDOW, SAMPLE FILTER, 47MM (KB)
016300600	ASSY, SAMPLE FILTER, 47MM, ANG BKT, 5UM
016910000	AKIT, EXP KIT, CO CATALYST
019340200	ASSY, SAMPLE THERMISTOR, M300E BRASS
033520000	MIRROR, OBJECT, 32 PASS, M300E (KB)
033560000	MIRROR, FIELD, 32 PASS, M300E (KB)
035950100	DOC, w/SOFTWARE, M300E (KB)* (USE WITH ACROSSER CPU 041710000)
036020100	ASSY, SENSOR, M300E, SN >=100 (KB)
037250000	ASSY, HEATER, OPTICAL BENCH
037860000	ORING, TFE RETAINER, SAMPLE FILTER
039260101	DETECTOR, CO, w/BANDPASS FILTER *
040010000	ASSY, FAN REAR PANEL, E SERIES
040030100	PCA, FLOW/PRESSURE
040370000	ASSY, CO SCRUBBER, M300E (KB)
041350000	PCA, RELAY BOARD, M300E
041710000	ASSY, CPU, CONFIGURATION, "E" SERIES * (USE WITH DOC 035950100)
042410100	ASSY, PUMP W/FLOW CONTROL
042410200	ASSY, PUMP, INT, SOX/O3/IR *
042580000	PCA, KEYBOARD, E-SERIES, W/V-DETECT
042680000	ASSY, VALVE, FOR SAMPLE/CAL VALVE ASSY
042690000	ASSY, VALVE, SHUT-OFF
042880000	MANUAL, OPERATORS, M300E/EM
042900100	PROGRAMMED FLASH, E SERIES
043250100	CONFIGURATION PLUGS, 115V/60Hz
043250300	CONFIGURATION PLUGS, 220-240V/50Hz
043250400	CONFIGURATION PLUGS, 220-240V/60Hz
043420000	ASSY, HEATER/THERMISTOR, O2 OPTION
043940000	PCA, INTERFACE, ETHERNET, E-SERIES

M300E Spare Parts List

(Reference: 05362J DCN5494)

Part Number	Description
048620200	PCA, SERIAL INTERFACE, w/ MD, E SERIES (USE WITH ACROSSER CPU 041710000)
050320000	PCA, PHOTO-INTERRUPTER
052830200	ASSY, MOTOR HUB, MR7, "E", 115V
055010000	ASSY, MTR WHL HEATER w/THERM, 200W
055100200	ASSY, OPTION, PUMP, 240V *
058021100	PCA, E-SERIES MOTHERBD, GEN 5-ICOP (ACCEPTS ACROSSER OR ICOP CPU)
062420200	PCA, SER INTRFACE, ICOP CPU, E- (OPTION) (USE WITH ICOP CPU 062870000)
062870000	CPU, PC-104, VSX-6150E, ICOP *(KB) (MUST USE WITH 058021100 MB)
063600100	DOM, w/SOFTWARE, M300E * (USE WITH ICOP CPU 062870000)
CN0000458	CONNECTOR, REAR PANEL, 12 PIN
CN0000520	CONNECTOR, REAR PANEL, 10 PIN
DS0000025	DISPLAY, E SERIES (KB)
FL0000001	FILTER, SS
FM0000004	FLOWMETER (KB)
HW0000005	FOOT, CHASSIS
HW0000020	SPRING
HW0000036	TFE TAPE, 1/4" (48 FT/ROLL)
HW0000101	ISOLATOR
HW0000453	SUPPORT, CIRCUIT BD, 3/16" ICOP
KIT000032	REPLACEMENT, CO FILTER WHEEL ASSY
KIT000178	RETROFIT, SYNC DMOD w/DETECTOR, M300E
KIT000219	PCA, 4-20MA OUTPUT, E-OPTION
OP0000009	WINDOW, IR SOURCE/BENCH
OR0000001	ORING, FLOW CONTROL
OR0000034	ORING, INPUT & OUTPUT MIRRORS
OR0000039	ORING, IR SOURCE/BENCH
OR0000041	ORING, OBJECT & FIELD MIRRORS
OR0000088	ORING, DETECTOR
OR0000094	ORING, SAMPLE FILTER
PS0000011	PWR SUPPLY, SW, +5V, +/-15V, 40W (KB)
PS0000024	COVER ENCLOSURE KIT,LPX 40/60 (KB)
PS0000025	PWR SUPPLY, SW, 12V, 40W (KB)
PU0000022	REBUILD KIT, FOR PU20 & 04241 (KB)
RL0000015	RELAY, DPDT, (KB)
SW0000051	SWITCH, POWER CIRC BREAK VDE/CE, w/RG(KB
SW0000059	PRESSURE SENSOR, 0-15 PSIA, ALL SEN
WR0000008	POWER CORD, 10A

M300EM Spare Parts List

(Reference: 05424H DCN5494)

Part Number	Description
000940600	ORIFICE, 10 MIL, SPAN GAS FLOW CONTROL
000941000	ORIFICE, 13 MIL (SAMPLE FLOW)
001760400	ASSY, SAMPLE FLOW CONTROL
001761300	ASSY, SPAN GAS FLOW CONTROL
003291500	ASSY, THERMISTOR, BENCH/WHEEL, M300E
009390000	APERTURE
009450300	ASSY, ZERO/SPAN VALVES, M300E
009550500	ASSY, SOURCE
009560301	FILTER WHEEL, CO
009600400	AKIT, EXPENDABLES, M300E
009690000	AKIT, TFE FLTR ELEM, FL6, 47MM (100=1)
009690100	AKIT, TFE FLTR, 47MM, (FL6) (30)
009840300	ASSY, SHUT-OFF VALVE W/FLOW CONTROL
010790000	INPUT MIRROR, REPLICATED(KB)
010800000	OUTPUT MIRROR, REPLICATED(KB)
016290000	WINDOW, SAMPLE FILTER
016300600	ASSY, SAMPLE FILTER
019340200	ASSY, SAMPLE THERMISTOR
026060000	MIRROR, OBJECTIVE, 8 PASS
026070000	MIRROR, FIELD, 8 PASS
036070000	OPTION, IZS & SO VALVE, M300E (KB)
036080000	OPTION, Z/S & SO VALVE, M3XXEX (KB)
036090000	OPTION, Z/S, M300E (KB)
036100000	OPTION, IZS, M300E (KB)
037250100	ASSY, BAND HEATER W/TC, M300EM/M3X0E
037860000	ORING, TFE RETAINER, SAMPLE FILTER
039260101	DETECTOR, CO, w/BANDPASS FILTER *
040010000	ASSY, FAN REAR PANEL, E SERIES
040030100	PCA, FLOW/PRESSURE
040360100	AKIT, SPARE PARTS, M300E
040370000	ASSY, CO SCRUBBER, M300E (KB)
041350000	PCA, RELAY BOARD, M300E
041710000	ASSY, CPU, CONFIGURATION, "E" SERIES * (USE WITH DOC 054400100)
042410100	ASSY, PUMP W/FLOW CONTROL
042410200	ASSY, PUMP, INT, SOX/O3/IR *
042580000	PCA, KEYBOARD, E-SERIES, W/V-DETECT
042680000	ASSY, VALVE, FOR SAMPLE/CAL VALVE ASSY
042690000	ASSY, VALVE, SHUT-OFF
042880000	MANUAL, OPERATORS, M300E/EM
042900100	PROGRAMMED FLASH, E SERIES
042990100	ASSY, SENSOR, M300EM
043250100	CONFIGURATION PLUGS, 115V/60Hz
043250300	CONFIGURATION PLUGS, 220-240V/50Hz
043250400	CONFIGURATION PLUGS, 220-240V/60Hz
043940000	PCA, INTERFACE, ETHERNET, E-SERIES
048620200	PCA, SERIAL INTERFACE, w/ MD, E SERIES (USE WITH ACROSSER CPU 041710000)
050320000	PCA, PHOTO-INTERRUPTER
052830200	ASSY, MOTOR HUB, MR7, "E", 115V
054400100	DOC, w/SOFTWARE, M300EM (USE WITH ACROSSER CPU 041710000)
055010000	ASSY, MTR WHL HEATER w/THERM, 200W
055100200	ASSY, OPTION, PUMP, 240V *

M300EM Spare Parts List

(Reference: 05424H DCN5494)

Part Number	Description
058021100	PCA, E-SERIES MOTHERBD, GEN 5-ICOP (ACCEPTS ACROSSER OR ICOP CPU)
062420200	PCA, SER INTRFACE, ICOP CPU, E- (OPTION) (USE WITH ICOP CPU 062870000)
062870000	CPU, PC-104, VSX-6150E, ICOP (MUST USE WITH 058021100)
063610100	DOM, w/SOFTWARE, M300EM (USE WITH ICOP CPU 062870000)
CN0000458	CONNECTOR, REAR PANEL, 12 PIN
CN0000520	CONNECTOR, REAR PANEL, 10 PIN
DS0000025	DISPLAY, E SERIES (KB)
FL0000001	FILTER, SS
FM0000004	FLOWMETER (KB)
HW0000005	FOOT, CHASSIS
HW0000020	SPRING
HW0000036	TFE TAPE, 1/4" (48 FT/ROLL)
HW0000101	ISOLATOR
HW0000453	SUPPORT, CIRCUIT BD, 3/16" ICOP
KIT000178	RETROFIT, SYNC DMOD w/DETECTOR, M300E
KIT000219	PCA, 4-20MA OUTPUT, E-OPTION
OP0000009	WINDOW, IR SOURCE/BENCH
OR0000001	ORING, FLOW CONTROL
OR0000034	ORING, INPUT & OUTPUT MIRRORS
OR0000039	ORING, IR SOURCE/BENCH
OR0000041	ORING, OBJECT & FIELD MIRRORS
OR0000088	ORING, DETECTOR
OR0000094	ORING, SAMPLE FILTER
PS0000011	PWR SUPPLY, SW, +5V, +/-15V, 40W (KB)
PS0000024	COVER ENCLOSURE KIT,LPX 40/60 (KB)
PS0000025	PWR SUPPLY, SW, 12V, 40W (KB)
PU0000022	REBUILD KIT, FOR PU20 & 04241 (KB)
RL0000015	RELAY
SW0000051	SWITCH, POWER
SW0000059	PRESSURE SENSOR, 0-15 PSIA, ALL SEN
WR0000008	POWER CORD, 10A

M300EM Recommended Spare Parts
Stocking Levels

(Reference: 04834G DCN5220)

Part Number	Description	1	2-5	6-10	11-20	21-30	UNITS
003291500	ASSY, THERMISTOR, BENCH/WHEEL, M300E	1	1	1	2	2	
009550500	ASSY, SOURCE, M300E S/N>65	1	1	2	2	3	
009560301	GF WHEEL, CO, M300A/E SERIES (KB) *	*	*	*	1	1	
037250100	ASSY, BAND HEATER W/TC, M300EM/M3X0E (KB	*	1	1	2	2	
040010000	ASSY, FAN REAR PANEL, E SERIES	1	1	2	2	3	
040030100	PCA, PRESS SENSORS (1X), w/FM4, E SERIES	*	*	1	2	3	
041350000	PCA, RELAY BOARD, M300E	*	1	1	2	2	
041710000	ASSY, CPU, CONFIGURATION, "E" SERIES	*	*	1	1	1	
042410200	ASSY, PUMP, INT, SOX/O3/IR *	*	*	*	2	2	*
042580000	PCA, KEYBOARD, E-SERIES, W/V-DETECT	*	*	*	1	1	
042680000	ASSY, VALVE (SS), M300E (KB)	*	*	1	1	2	**With IZS, ZS Option**
042690000	ASSY, VALVE , 2-WAY, 12V	*	*	1	1	2	**With IZS, ZS Option**
050320000	PCA, OPTO-INTERRUPTER, M300E	*	1	1	2	2	
052830100	ASSY, MOTOR HUB, MR7, "A", 115V	*	*	1	1	2	
055010000	ASSY, MTR WHL HEATER w/THERM, 200W	*	*	1	2	2	
058021100	PCA, E-SERIES MOTHERBOARD, GEN 5-I	*	*	*	1	2	
DS0000025	DISPLAY, E SERIES (KB)	*	*	*	1	1	
KIT000179	RETROFIT, SYNC DMOD UPDATE, M300EM	*	*	1	2	2	
OP0000030	OXYGEN TRANSDUCER, PARAMAGNETIC	*	*	*	1	1	**With O2 Option**
PS0000011	PWR SUPPLY, SW, +5V, +/-15V, 40W (KB)	*	*	1	2	2	
PS0000025	PWR SUPPLY, SW, 12V, 40W (KB)	*	*	1	2	2	
RL0000015	RELAY, DPDT, (KB)	1	1	2	2	2	
* For 240V operation, use 055100200							

M300E/EX Expendables Kit

(Reference: 0096004C)

Part Number	Description	Quantity
009690100	AKIT, TEFLON FILTER ELEMENTS, 47MM, 5UM (25)	1
FL0000001	FILTER, SS	1
HW0000020	SPRING	1
NOTE01-023	SERVICE NOTE, HOW TO REBUILD KNF PUMP	1
OR0000001	ORING, FLOW CONTROL	2
PU0000022	REBUILD KIT, FOR PU20 & 04084	1

Part Number	Description	Quantity
000941000	ORIFICE, 13 MIL (SAMPLE FLOW)	1
009550500	ASSY, SOURCE	1
040010000	ASSY, FAN, REAR PANEL, E SERIES	1
RL0000015	RELAY	1

Model M300EU Recommended Spare Parts Stocking Levels

(Reference: 04302Q DCN5480 + updates 06/15/2011)

003291500

009550500 ASSY, SOURCE

009560301	GF WHEEL, CO, (KB) *	Units				
		1	2-5	6-10	11-20	21-30
040010000	ASSY, FAN REAR PANEL	1	1	1	2	2
040030100	PCA, PRESS SENSORS (1X), w/FM4	1	1	1	2	2
041350000	PCA, RELAY BOARD, CO(KB)	1	1	2	2	3
042410200	ASSY, PUMP, INT, SOX/O3/IR *				1	1
042580000	PCA, KEYBOARD, W/V-DETECT(KB)		1	1	2	2
042680000	ASSY, VALVE (SS)	1	1	2	2	3
042690000	ASSY, VALVE , 2-WAY, 12V			1	2	3
050320000	PCA, OPTO-INTERRUPTER		1	1	2	2
052830200	ASSY, MOTOR HUB, MR7			1	2	2
055010000	ASSY, MTR WHL HEATER w/THERM, 200W				1	1
058021100	PCA, MOTHERBD, GEN 5-ICOP		1	1	2	2
062870000	CPU, PC-104, VSX-6150E, ICOP (KB)*			1	1	2
DR0000007	PERMAPURE DREYER, 100 TUBE, 12"(KB)			1	2	2
DS0000025	DISPLAY(KB)			1	1	2
KIT000178	RETROFIT, SYNC DMOD w/DETECTOR*				1	2
KIT000202	REPLACEMENT, CO FILTER WHEEL, M300E				1	2
OP0000030	OXYGEN TRANSDUCER, PARAMAGNETIC				1	2
PS0000011	PWR SUPPLY, SW, +5V, +/-15V, 40W (KB)				1	2
PS0000025	PWR SUPPLY, SW, 12V, 40W (KB)			1	1	1
RL0000015	RELAY, DPDT, (KB)				1	1
DS0000025	DISPLAY, E SERIES (KB)				1	1
KIT000283	RETROFIT, SYNC DMOD w/DETECTOR, M300EU			1	2	2
KIT000202	REPLACEMENT, CO FILTER WHEEL, M300E				1	1
PS0000011	PWR SUPPLY, SW, +5V, +/-15V, 40W (KB)			1	2	2
PS0000025	PWR SUPPLY, SW, 12V, 40W (KB)			1	2	2
RL0000015	RELAY, DPDT, (KB)	1	1	2	2	2

*** Recommended Spare Parts Stocking Level: For Pump Assembly, 240V Option Installed**

Part Number	Description	Units				
		1	2-5	6-10	11-20	21-30
055100200	OPTION, PUMP ASSY, 240V			1	2	2

Recommended Spare Parts Stocking Level: For O_2 Option Installed

Part Number	Description	Units				
		1	2-5	6-10	11-20	21-30
OP0000030	OXYGEN TRANSDUCER, PARAMAGNETIC				1	1

Recommended Spare Parts Stocking Level: For IZS Option Installed

Part Number	Description	Units				
		1	2-5	6-10	11-20	21-30
042690000	Valve Assy, 2-Way, On/Off			1	1	2
042680000	Valve Assy, 3-Way			1	1	2

APPENDIX C **Warranty/Repair Questionnaire** **T300/T300M and M300E/EM** (04305G DCN5798)	TELEDYNE ADVANCED POLLUTION INSTRUMENTATION A Teledyne Technologies Company

CUSTOMER: ______________________________ PHONE: ______________________________

CONTACT NAME: ___________________________ FAX NO: ______________________________

SITE ADDRESS: ____

SERIAL NO.: ______________________________ FIRMWARE REVISION: _____________________

1. Are there any failure messages? ____

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Please complete the following table:

PARAMETER	DISPLAYED AS	OBSERVED VALUE	UNITS	NOMINAL RANGE
Range	Range		PPM, MGM[1,2] PPB, UGM[1]	1 – 1000 PPM[1] 5 – 5000 PPM[2]
Stability	STABIL		PPM	<1.0 PPM with Zero Air
CO Measure	CO MEAS		mV	2500 – 4800 MV
CO Reference	CO REF		mV	2500 – 4800MV
Measure/Reference Ratio	MR RATIO		–	1.1 – 1.3 W/ Zero Air
Pressure	PRES		In-Hg-A	-2"Ambient Absolute
Sample Flow	SAMP FL		cm^3/min	800 ± 10%
Sample Temp	SAMPLE TEMP		°C	48 ± 4
Bench Temp	BENCH TEMP		°C	48 ± 2
Wheel Temp	WHEEL TEMP		°C	68 ± 2
Box Temp	BOX TEMP		°C	Ambient + 7 ± 10
Photo Drive	PHT DRIVE		mV	250 mV – 4750 mV
Slope of CO Measurement	CO SLOPE		–	1.0 ± .3
Offset of CO Measurement	CO OFFSET		PPM	0 ± 0.3
Dark Cal Reference signal	REF DARK OFFSET		mV	125 ± 50 mV
Dark Cal Measurement Signal	MEAS DARK OFFSET		mV	125 ± 50 mV
Electric Test			PPM	40 ± 2 PPM

[1] T300, M300E [2] T300M, M300EM

TELEDYNE API CUSTOMER SERVICE
Email: api-customerservice@teledyne.com
PHONE: (858) 657-9800 TOLL FREE: (800) 324-5190 FAX: (858) 657-9816

2. Have you performed a leak check and flow check? ______________________________

3. What are the failure symptoms? ______________________________

____

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4. What test have you done trying to solve the problem? ______________________________

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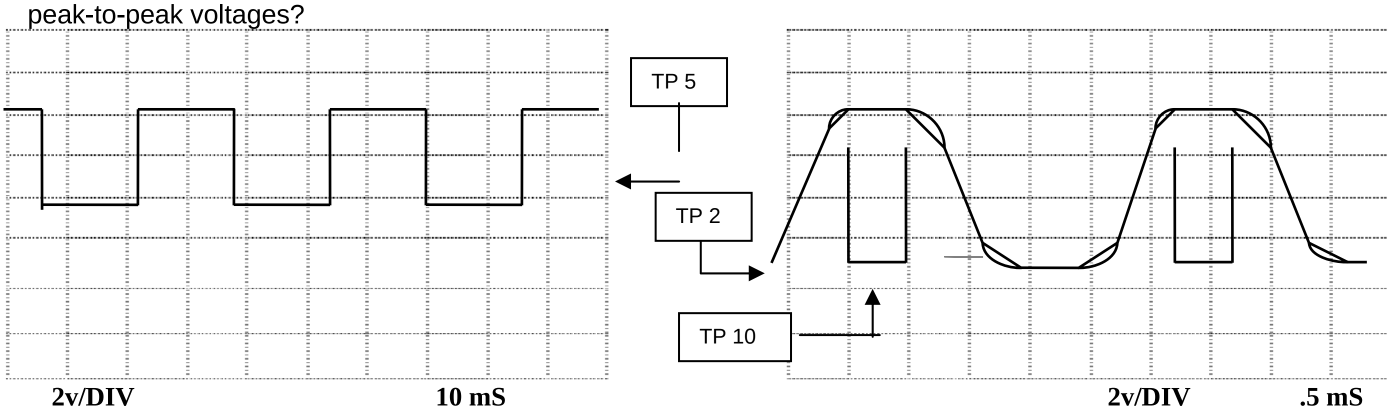
5. Please check these signals and verify the correctness. Look for the signals annotated on the diagram. What are the peak-to-peak voltages?



5. If possible, please include a portion of a strip chart pertaining to the problem. Circle pertinent data.

Thank you for providing this information. Your assistance enables Teledyne API to respond faster to the problem that you are encountering.

OTHER INFORMATION: ______________________________

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TELEDYNE API CUSTOMER SERVICE
Email: api-customerservice@teledyne.com
PHONE: (858) 657-9800 TOLL FREE: (800) 324-5190 FAX: (858) 657-9816

APPENDIX D – Wire List and Electronic Schematics

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Interconnect List, M300E/EU, SNs 100 and greater

(Reference: 04217F)

Revision	Description	Checked	Date	DCN
A	Initial release			
B	Corrections: dropped +12V & +12V return from 03648, corrected +12V & Cgnd on 03829, cable 04238 to 036490100, corrected incorrect TO PN on 036490100 from 03134 (relay board) to 04135, added L & N to AC-switched conductors, switched L & N pins on PS1 & 2 of SK2		7/17/2002	2321
C	Change to expanded relay board	KV	8/4/04	3197
D	03648: corrected CO2 sensor wiring	BK	9/2/2005	3694
E	Updated Part numbers	KV	1/4/2007	4318
F	Added M300EU2 blower htrs, removed cbl to keybd J2, added I2C cbl fr mb to relay bd	RH	3/3/2007	4411

		FROM				TO			
Cable PN	**Signal**	**Assembly**	**PN**	**J/P**	**Pin**	**Assembly**	**PN**	**J/P**	**Pin**
007290000	**CBL, KEYBOARD/DISPLAY**								
	D7	Display	DS0000025	CN1	1	Keyboard/Interface	042580000	J3	1
	D6	Display	DS0000025	CN1	2	Keyboard/Interface	042580000	J3	2
	D5	Display	DS0000025	CN1	3	Keyboard/Interface	042580000	J3	3
	D4	Display	DS0000025	CN1	4	Keyboard/Interface	042580000	J3	4
	D3	Display	DS0000025	CN1	5	Keyboard/Interface	042580000	J3	5
	D2	Display	DS0000025	CN1	6	Keyboard/Interface	042580000	J3	6
	D1	Display	DS0000025	CN1	7	Keyboard/Interface	042580000	J3	7
	D0	Display	DS0000025	CN1	8	Keyboard/Interface	042580000	J3	8
	DISP WRITE	Display	DS0000025	CN1	9	Keyboard/Interface	042580000	J3	9
	DGND	Display	DS0000025	CN1	10	Keyboard/Interface	042580000	J3	10
	Spare	Display	DS0000025	CN1	11	Keyboard/Interface	042580000	J3	11
	DISP_BUSY	Display	DS0000025	CN1	12	Keyboard/Interface	042580000	J3	12
	DISP_RETURN	Display	DS0000025	CN1	13	Keyboard/Interface	042580000	J3	13
	DISP_RETURN	Display	DS0000025	CN1	14	Keyboard/Interface	042580000	J3	14
	DISP_PWR	Display	DS0000025	CN1	15	Keyboard/Interface	042580000	J3	15
	DISP_PWR	Display	DS0000025	CN1	16	Keyboard/Interface	042580000	J3	16
0364801	**CBL ASSY, SYNC DEMOD TO MTHBD, DC, M300E/EU**								
	DGND	Relay Board	041350000	J15	1	Sync Demod	032960000	J2	1
	+5V	Relay Board	041350000	J15	2	Sync Demod	032960000	J2	2
	AGND	Relay Board	041350000	J15	3	Sync Demod	032960000	J2	3
	+15V	Relay Board	041350000	J15	4	Sync Demod	032960000	J2	4
	AGND	Relay Board	041350000	J15	5	Sync Demod	032960000	J2	5
	-15V	Relay Board	041350000	J15	6	Sync Demod	032960000	J2	6
	DGND	Relay Board	041350000	J15	6	Sync Demod	032960000	J2	6
	DGND	Relay Board	041350000	J15	1	O2 Sensor	049210000	P1	5
	+5V	Relay Board	041350000	J15	2	O2 Sensor	049210000	P1	6
	+12V ret	Relay Board	041350000	J15	7	Small Blower Fan	058810000		1
	+12V	Relay Board	041350000	J15	8	Small Blower Fan	058810000		2
	O2-	O2 Sensor		P1	9	Motherboard	057020100	P110	10
	O2+	O2 Sensor		P1	10	Motherboard	057020100	P110	4
	CO2-	CO2 Sensor			0	Motherboard	057020100	P110	8
	CO2+	CO2 Sensor			V	Motherboard	057020100	P110	2
036490100	**CBL ASSY, AC POWER, M300E, SN >=100**								
	AC Line	Power Entry	CN0000073		L	Power Switch	SW0000051		L
	AC Neutral	Power Entry	CN0000073		N	Power Switch	SW0000051		N
	Power Grnd	Power Entry	CN0000073			Shield			
	Power Grnd	Power Entry	CN0000073			Chassis			
	AC Line Switched	Power Switch	SW0000051		L	PS2 (+12)	PS0000025	SK2	1
	AC Neu Switched	Power Switch	SW0000051		N	PS2 (+12)	PS0000025	SK2	3
	Power Grnd	Power Entry	CN0000073			PS2 (+12)	PS0000025	SK2	2
	AC Line Switched	Power Switch	SW0000051		L	PS1 (+5, ±15)	PS0000011	SK2	1
	AC Neu Switched	Power Switch	SW0000051		N	PS1 (+5, ±15)	PS0000011	SK2	3
	Power Grnd	Power Entry	CN0000073			PS1 (+5, ±15)	PS0000011	SK2	2
	AC Line Switched	Power Switch	SW0000051		L	Relay	041350000	J1	1
	AC Neu Switched	Power Switch	SW0000051		N	Relay	041350000	J1	3
	Power Grnd	Power Entry	CN0000073			Relay	041350000	J1	2
03787	**CBL ASSY, BENCH HEATER, M300E**								
03787	Wheel Heater	Wiring harness	037990000	P1	1	Wheel Heater	055010000	P1	1
	AC Return	Wiring harness	037990000	P1	4	Wheel Heater	055010000	P1	2
	Bench Htr, 115V	Wiring harness	037990000	P1	2	Bench Htr	037250000	P1	1
	Bench Htr, 230V	Wiring harness	037990000	P1	3	Bench Htr	037250000	P1	2
	AC Return	Wiring harness	037990000	P1	4	Bench Htr	037250000	P1	3
	Chassis Gnd	Wiring harness	037990000	P1	5				
03789	**CBL ASSY, DC POWER, E SERIES**								
	+15	PS1	PS0000011	SK1	1	Relay Board	041350000	J13	4
	+5	PS1	PS0000011	SK1	2	Relay Board	041350000	J13	2
	DGND	PS1	PS0000011	SK1	4	Relay Board	041350000	J13	1
	AGND	PS1	PS0000011	SK1	5	Relay Board	041350000	J13	5
	-15	PS1	PS0000011	SK1	6	Relay Board	041350000	J13	6
	+12	PS2	PS0000025	SK1	1	Relay Board	041350000	J13	8
	+12 RET	PS2	PS0000025	SK1	4	Relay Board	041350000	J13	7

Interconnect List, M300E/EU, SNs 100 and greater
(Reference: 04217F)

		FROM				TO			
Cable PN	**Signal**	**Assembly**	**PN**	**J/P**	**Pin**	**Assembly**	**PN**	**J/P**	**Pin**
03799	**CBL ASSY, RELAY BD TO BENCH HTR, M300E**								
	Wheel Heater	Relay Board	041350000	J3	1	Wiring harness	037870000	J1	1
	Bench Htr,115V	Relay Board	041350000	J3	2	Wiring harness	037870000	J1	2
	Bench Htr, 230V	Relay Board	041350000	J3	3	Wiring harness	037870000	J1	3
	AC Return	Relay Board	041350000	J3	4	Wiring harness	037870000	J1	4
	Chassis Gnd	Relay Board	041350000	J3	5	Wiring harness	037870000	J1	5
03829	**CBL ASSY, DC POWER TO MOTHERBOARD, E SER**								
	DGND	Relay Board	041350000	J14	1	Motherboard	057020100	J15	1
	+5V	Relay Board	041350000	J14	2	Motherboard	057020100	J15	2
	AGND	Relay Board	041350000	J14	3	Motherboard	057020100	J15	3
	+15V	Relay Board	041350000	J14	4	Motherboard	057020100	J15	4
	AGND	Relay Board	041350000	J14	5	Motherboard	057020100	J15	5
	-15V	Relay Board	041350000	J14	6	Motherboard	057020100	J15	6
	+12V RET	Relay Board	041350000	J14	7	Motherboard	057020100	J15	7
	+12V	Relay Board	041350000	J14	8	Motherboard	057020100	J15	8
	Chassis Gnd	Relay Board	041350000	J14	10	Motherboard	057020100	J15	9
03902	**CBL, RELAY BD TO SOURCE, M300E**								
	IR Source Drv	Relay Board	041350000	J16	1	IR Source	009550500	P1	1
	IR Source Drv	Relay Board	041350000	J16	2	IR Source	009550500	P1	2
03995	**CBL, MOTOR TO RELAY BOARD, M300E**								
	GFC Drive - A	Relay Board	041350000	J6	1	GFC Motor	052380200	P1	1
	GFC Drive - B	Relay Board	041350000	J6	2	GFC Motor	052380200	P1	2
	Motor Return	Relay Board	041350000	J6	3	GFC Motor	052380200	P1	3
	Chassis Gnd	Relay Board	041350000	J6	4	GFC Motor	052380200	P1	4
04023	**CBL, I2C, relay board to motherboard, E-series**								
	I2C Serial Clock	Motherboard	057020100	P107	3	Relay Board	045230100	P5	1
	I2C Serial Data	Motherboard	057020100	P107	5	Relay Board	045230100	P5	2
	I2C Reset	Motherboard	057020100	P107	2	Relay Board	045230100	P5	4
	I2C Shield	Motherboard	057020100	P107	6	Relay Board	045230100	P5	5
04103	**CBL, MTHR BR TO THERMISTORS, M300E**								
	+5V Ref	Motherboard	057020100	J27	6	Bench Temp Snsr	003290500	P1	1
	Bench Temp	Motherboard	057020100	J27	13	Bench Temp Snsr	003290500	P1	2
	+5V Ref	Motherboard	057020100	J27	5	Wheel Temp Snsr	003290500	P1	1
	Wheel Temp	Motherboard	057020100	J27	12	Wheel Temp Snsr	003290500	P1	2
	+5V ref	Motherboard	057020100	J27	1	Shield			
	+5V Ref	Motherboard	057020100	J27	7	Sample Temp Snsr	019340200	P1	1
	Sample Temp	Motherboard	057020100	J27	14	Sample Temp Snsr	019340200	P1	2
		Motherboard	057020100	J27	2	O2 Sensor Therm/Htr	043420000	P1	3
		Motherboard	057020100	J27	9	O2 Sensor Therm/Htr	043420000	P1	1
		Relay Board	041350000	J4	1	O2 Sensor Therm/Htr	043420000	P1	4
		Relay Board	041350000	J4	2	O2 Sensor Therm/Htr	043420000	P1	2
		Relay Board	041350000	J4	3	Shield			
0410401	**CBL, DC PWR & SIGNAL DISTRIB, M300E/EU**								
	+5V	Keyboard	042580000	J1	1	Relay Board	041350000	J12	2
	DGND	Keyboard	042580000	J1	2	Relay Board	041350000	J11	1
	+5V	Keyboard	042580000	J1	3	Relay Board	041350000	J11	2
	SDA	Keyboard	042580000	J1	5	Motherboard	057020100	J106	2
	SCL	Keyboard	042580000	J1	6	Motherboard	057020100	J106	6
	KBINT	Keyboard	042580000	J1	7	Motherboard	057020100	J106	1
	DGND	Keyboard	042580000	J1	8	Relay Board	041350000	J12	1
	Shield	Keyboard	042580000	J1	10	Shield			
	GND	Ethernet	043940000	J1	1	Relay Board	041350000	J11	1
	+5V	Ethernet	043940000	J1	2	Relay Board	041350000	J11	2
	+12V Ret	Rear Panel Fan	040010000	P1	1	Relay Board	041350000	J11	7
	+12V	Rear Panel Fan	040010000	P1	2	Relay Board	041350000	J11	8
	AGND	Flow Module	040030100	J1	3	Relay Board	041350000	J11	3
	+15V	Flow Module	040030100	J1	6	Relay Board	041350000	J11	4
	Cell Pressure	Flow Module	040030100	J1	4	Motherboard	057020100	J109	5
	Pump Vaccum	Flow Module	040030100	J1	2	Motherboard	057020100	J109	6
	Sample Flow	Flow Module	040030100	J1	5	Motherboard	057020100	J109	2
	AGND	Flow Module	040030100	J1	Shld	Motherboard	057020100	J109	9
	Measure	Sync Demod	032960000	J3	1	Motherboard	057020100	J109	4
	PD Temp	Sync Demod	032960000	J3	2	Motherboard	057020100	J109	1
	Reference	Sync Demod	032960000	J3	5	Motherboard	057020100	J109	3
	AGND	Sync Demod	032960000	J3	6	Shield			
	Dark Switch	Sync Demod	032960000	J3	4	Motherboard	057020100	J108	16
	Sync Error	Sync Demod	032960000	J3	7	Motherboard	057020100	J108	4
	Etest	Sync Demod	032960000	J3	8	Motherboard	057020100	J108	8
	+12V Ret	Relay Board	041350000	J12	7	Bench Blower Fan 1	058790000		1
	+12V	Relay Board	041350000	J12	8	Bench Blower Fan 1	058790000		2
	+12V Ret	Relay Board	041350000	J12	7	Bench Blower Fan 2	058790000		1
	+12V	Relay Board	041350000	J12	8	Bench Blower Fan 2	058790000		2

Interconnect List, M300E/EU, SNs 100 and greater
(Reference: 04217F)

		FROM				TO			
Cable PN	**Signal**	**Assembly**	**PN**	**J/P**	**Pin**	**Assembly**	**PN**	**J/P**	**Pin**
04146	**CBL, SYNC DEMOD, M300E**								
	DGND	Opto Pickup	050320000	J1	1	Sync Demod	032960000	JP4	6
	Segmentg Gate	Opto Pickup	050320000	J1	2	Sync Demod	032960000	JP4	5
	No Connection	Opto Pickup	050320000	J1	3	Sync Demod	032960000	JP4	4
	DGND	Opto Pickup	050320000	J1	4	Sync Demod	032960000	JP4	3
	M/R Gate	Opto Pickup	050320000	J1	5	Sync Demod	032960000	JP4	2
	+5V	Opto Pickup	050320000	J1	6	Sync Demod	032960000	JP4	1
04211	**CBL, MTHBD TO CPU, (KB)**								
	RXD(0)	CPU	CP0000026	CN3	3	Motherboard	057020100	J12	14
	RTS(0)	CPU	CP0000026	CN3	4	Motherboard	057020100	J12	13
	TXD(0)	CPU	CP0000026	CN3	5	Motherboard	057020100	J12	12
	CTS(0)	CPU	CP0000026	CN3	6	Motherboard	057020100	J12	11
	GND(0)	CPU	CP0000026	CN3	9	Motherboard	057020100	J12	10
	RXD(1)	CPU	CP0000026	CN4	3	Motherboard	057020100	J12	9
	RTS(1)	CPU	CP0000026	CN4	4	Motherboard	057020100	J12	8
	TXD(1)	CPU	CP0000026	CN4	5	Motherboard	057020100	J12	7
	CTS(1)	CPU	CP0000026	CN4	6	Motherboard	057020100	J12	6
	GND(1)	CPU	CP0000026	CN4	9	Motherboard	057020100	J12	5
	485+	CPU	CP0000026	CN5	2	Motherboard	057020100	J12	9
	485-	CPU	CP0000026	CN5	4	Motherboard	057020100	J12	7
	GND	CPU	CP0000026	CN5	6	Motherboard	057020100	J12	5
	Shield					Motherboard	057020100	J12	2
04237	**CBL ASSY, 12V VALVE CBLS, M300E, SN>=100**								
	+12	Relay Board	041350000	J7	6	Zero/Span Vlv	042680000	P1	1
	Zero/Span Drv	Relay Board	041350000	J7	8	Zero/Span Vlv	042680000	P1	2
	+12	Relay Board	041350000	J7	2	Samp/Cal Vlv	042680000	P1	1
	Samp/Cal Drv	Relay Board	041350000	J7	4	Samp/Cal Vlv	042680000	P1	2
	+12	Relay Board	041350000	J7	5	Shutoff Valve	042690000	P1	1
	Shutoff Vlv (M300E), Sample/Ref (M300EU)	Relay Board	041350000	J7	7	Shutoff Vlv (Sample/Ref)	042690000	P1	2
	+12	Relay Board	041350000	J7	1	Shutoff Vlv (Sample/Ref)	042690000	P1	1
	Shutoff Vlv (M300EU)	Relay Board	041350000	J7	3	Shutoff Valve (M300EU)	042690000	P1	2
04339	**CBL, CPU TO ETHERNET BD**								
	shld	Ethernet	043940000	PL101	2	CPU	CP0000026	CN4	
	txd	Ethernet	043940000	PL101	3	CPU	CP0000026	CN4	3
	dtr	Ethernet	043940000	PL101	4	CPU	CP0000026	CN4	2
	rts	Ethernet	043940000	PL101	5	CPU	CP0000026	CN4	6
	dcd	Ethernet	043940000	PL101	6	CPU	CP0000026	CN4	1
	rxd	Ethernet	043940000	PL101	8	CPU	CP0000026	CN4	5
	dsr	Ethernet	043940000	PL101	9	CPU	CP0000026	CN4	7
	cts	Ethernet	043940000	PL101	10	CPU	CP0000026	CN4	4
	gnd	Ethernet	043940000	PL101	16	CPU	CP0000026	CN4	9
05917	**CBL, BLOWER HTR CONFIG (M300EU ONLY)**								
	Oven Temp	Oven Therm	058800000	THERM	1	Cbl, Mthr Bd to Therm	041030000	O2	1
	+5V Ref	Oven Therm	058800000	THERM	2	Cbl, Mthr Bd to Therm	041030000	O2	3
	Config Jumper	Oven Htr 1	058810000	HTR1	1	Blower Htr Config Plug	05918	PLUG	1
	Config Jumper	Oven Htr 1	058810000	HTR1	2	Blower Htr Config Plug	05918	PLUG	2
	AC Line	Oven Htr 1	058810000	HTR1	2	Cbl, Mthr Bd to Therm	041030000	O2	4
	AC Neutral	Oven Htr 2	058810000	HTR2	1	Cbl, Mthr Bd to Therm	041030000	O2	2
	Config Jumper	Oven Htr 2	058810000	HTR2	1	Blower Htr Config Plug	05918	PLUG	4
	Config Jumper	Oven Htr 2	058810000	HTR2	2	Blower Htr Config Plug	05918	PLUG	5

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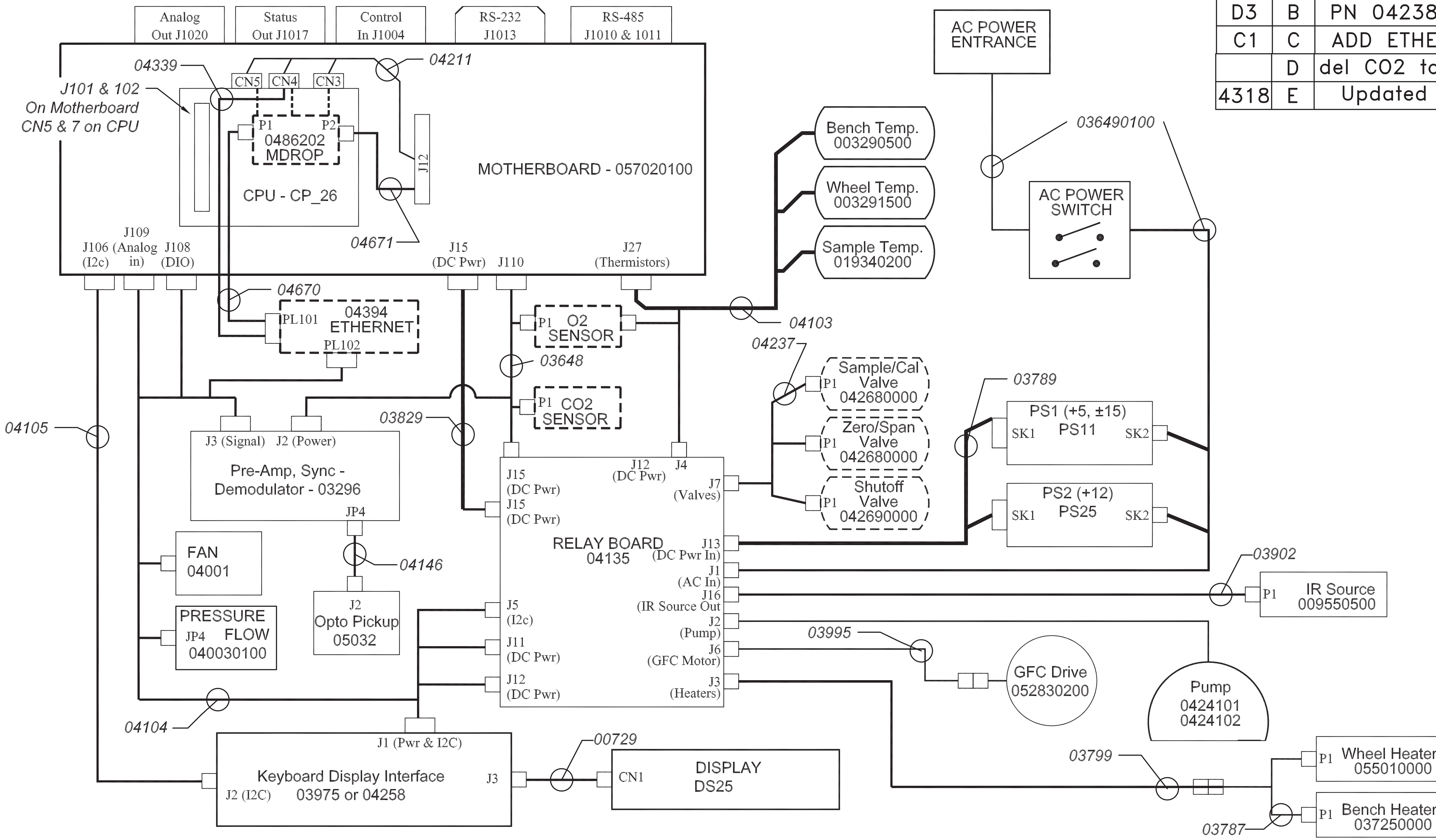
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	INITIAL RELEASE		
D3	B	PN 04238 to 036490100	7/11/02	
C1	C	ADD ETHERNET & MDROP	8/30/04	KV
	D	del CO2 to J12 (relay bd)	11/2/05	BK
4318	E	Updated Part Numbers	1/4/07	KV



PRINTED DOCUMENTS ARE UNCONTROLLED

KEY:

1. All part numbers in *Italic* identify cables that are refered to in the accompanying document 04217.
2. All items in Dashed boxes are optional.

THIRD ANGLE PROJECTION

PART DASH NO	NEXT	FINAL	NEXT ASSY	USED ON
	QTY REQD PER ASSY		APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:

FRACTIONS	DECIMALS	ANGULAR
± 1/32	±.03 ±.010	±0° 30'

DO NOT SCALE DRAWING

TREATMENT NA

FINISH N/A

SIMILAR TO

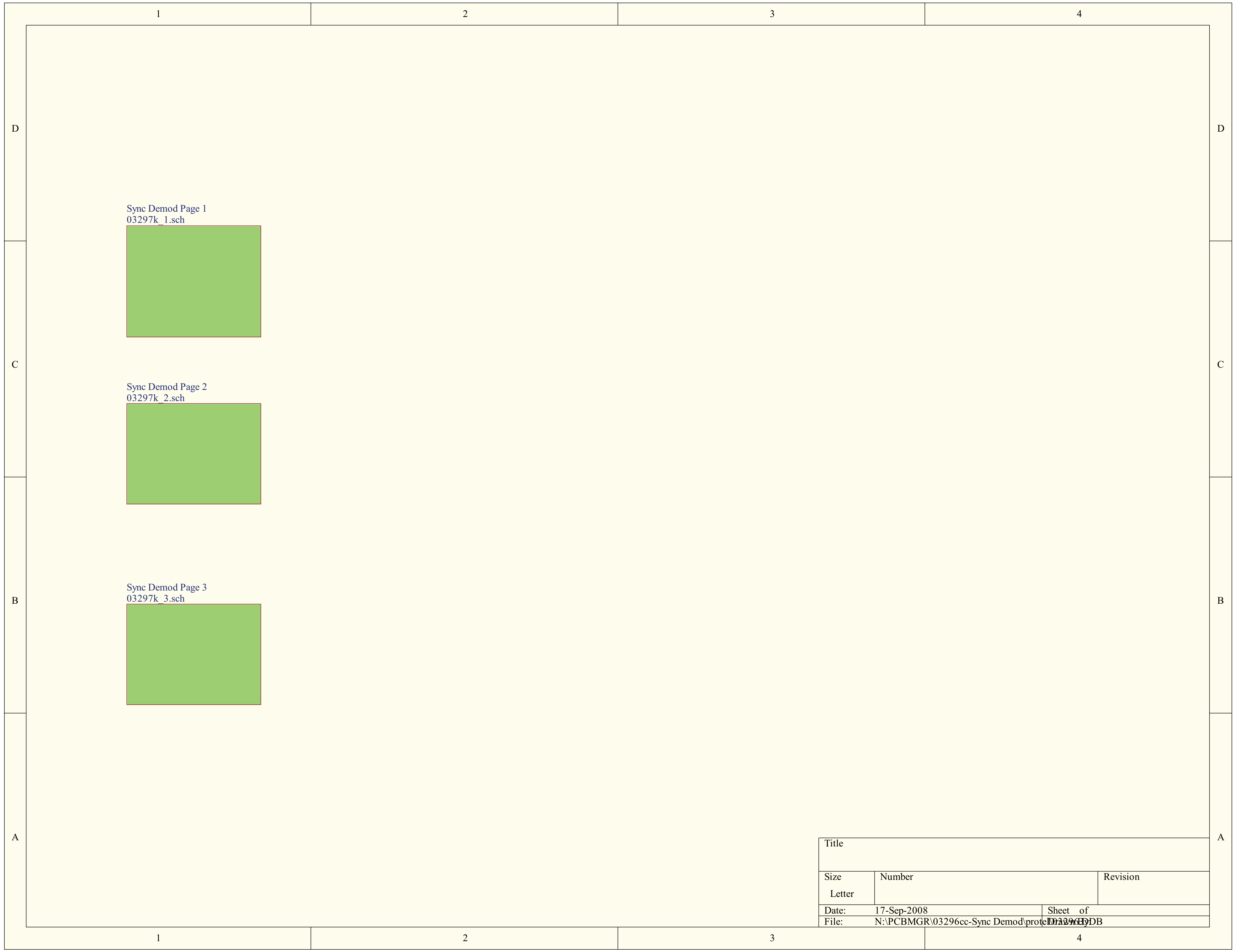
CONTRACT: NA

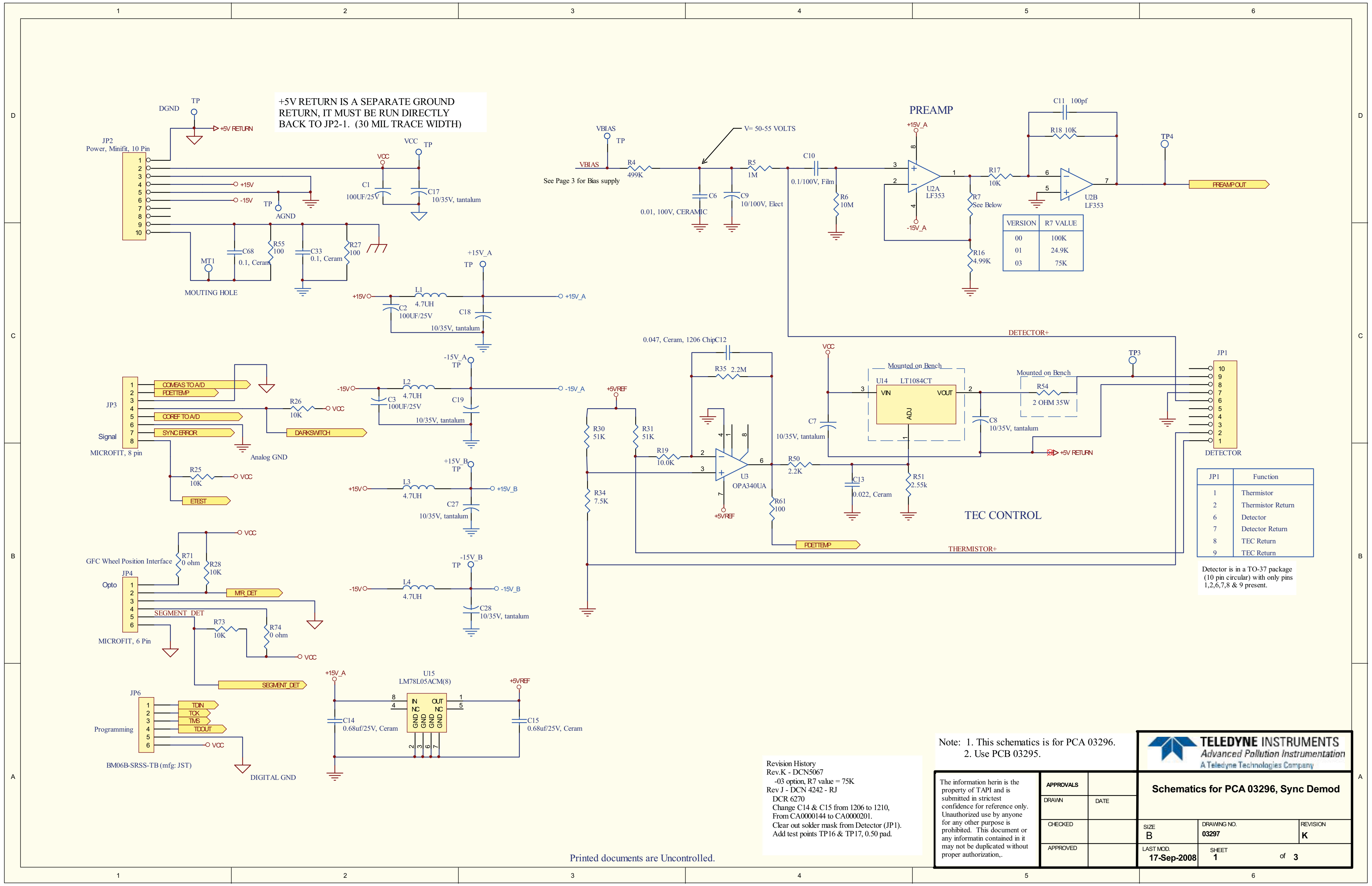
APPROVALS		DATE
DRAWN	D. NEU	1/25/02
CHECK		
CCB		
ISSUED		

API ADVANCED POLLUTION INSTRUMENTATION, INC. SAN DIEGO, CA

TITLE Interconnect Drawing, M300E, SNs >=100

SIZE	CAGE CODE NO.	DWG. NO.	REV
B	1JZF4	04216	E
SCALE E		FILE 04216	SHEET 1 OF 1


Sync Demod Page 1
03297k_1.sch
Sync Demod Page 2
03297k_2.sch
Sync Demod Page 3
03297k_3.sch
Title
Size
Letter
Number
Revision
Date: 17-Sep-2008
Sheet of
File: N:\PCBMGR\03296cc-Sync Demod\protel\03296.DDB
Drawn By:


+5V RETURN IS A SEPARATE GROUND RETURN, IT MUST BE RUN DIRECTLY BACK TO JP2-1. (30 MIL TRACE WIDTH)
PREAMP
TEC CONTROL
JP2
Power, Minifit, 10 Pin
JP3
MICROFIT, 8 pin
JP4
GFC Wheel Position Interface
MICROFIT, 6 Pin
JP6
Programming
BM06B-SRSS-TB (mfg: JST)
DIGITAL GND
Analog GND
MOUTING HOLE
See Page 3 for Bias supply
V= 50-55 VOLTS
Mounted on Bench
DETECTOR+
THERMISTOR+
DETECTOR
VERSION | R7 VALUE
00 | 100K
01 | 24.9K
03 | 75K
JP1 | Function
1 | Thermistor
2 | Thermistor Return
6 | Detector
7 | Detector Return
8 | TEC Return
9 | TEC Return
Detector is in a TO-37 package (10 pin circular) with only pins 1,2,6,7,8 & 9 present.
Revision History
Rev.K - DCN5067
-03 option, R7 value = 75K
Rev J - DCN 4242 - RJ
DCR 6270
Change C14 & C15 from 1206 to 1210,
From CA0000144 to CA0000201.
Clear out solder mask from Detector (JP1).
Add test points TP16 & TP17, 0.50 pad.
Note: 1. This schematics is for PCA 03296.
2. Use PCB 03295.
TELEDYNE INSTRUMENTS
Advanced Pollution Instrumentation
A Teledyne Technologies Company
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Schematics for PCA 03296, Sync Demod
SIZE B
DRAWING NO. 03297
REVISION K
LAST MOD. 17-Sep-2008
SHEET 1 of 3
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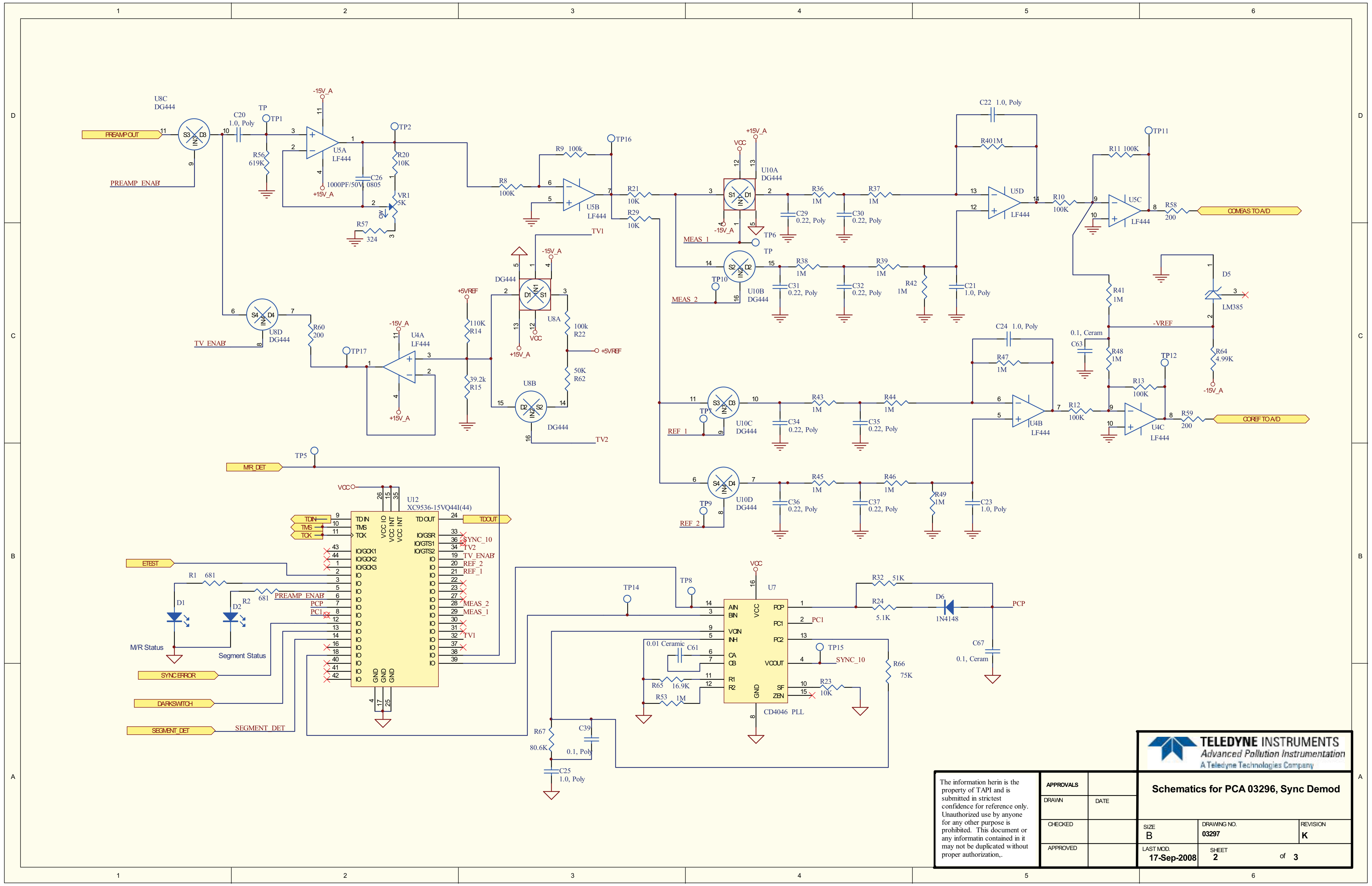

PREAMP OUT
PREAMP_ENAB'
TV_ENAB'
M/R_DET
ETEST
SYNC ERROR
DARKSWITCH
SEGMENT_DET
M/R Status
Segment Status
COMEAS TO A/D
COREF TO A/D
U12
XC9536-15VQ44I(44)
CD4046 PLL
LM385
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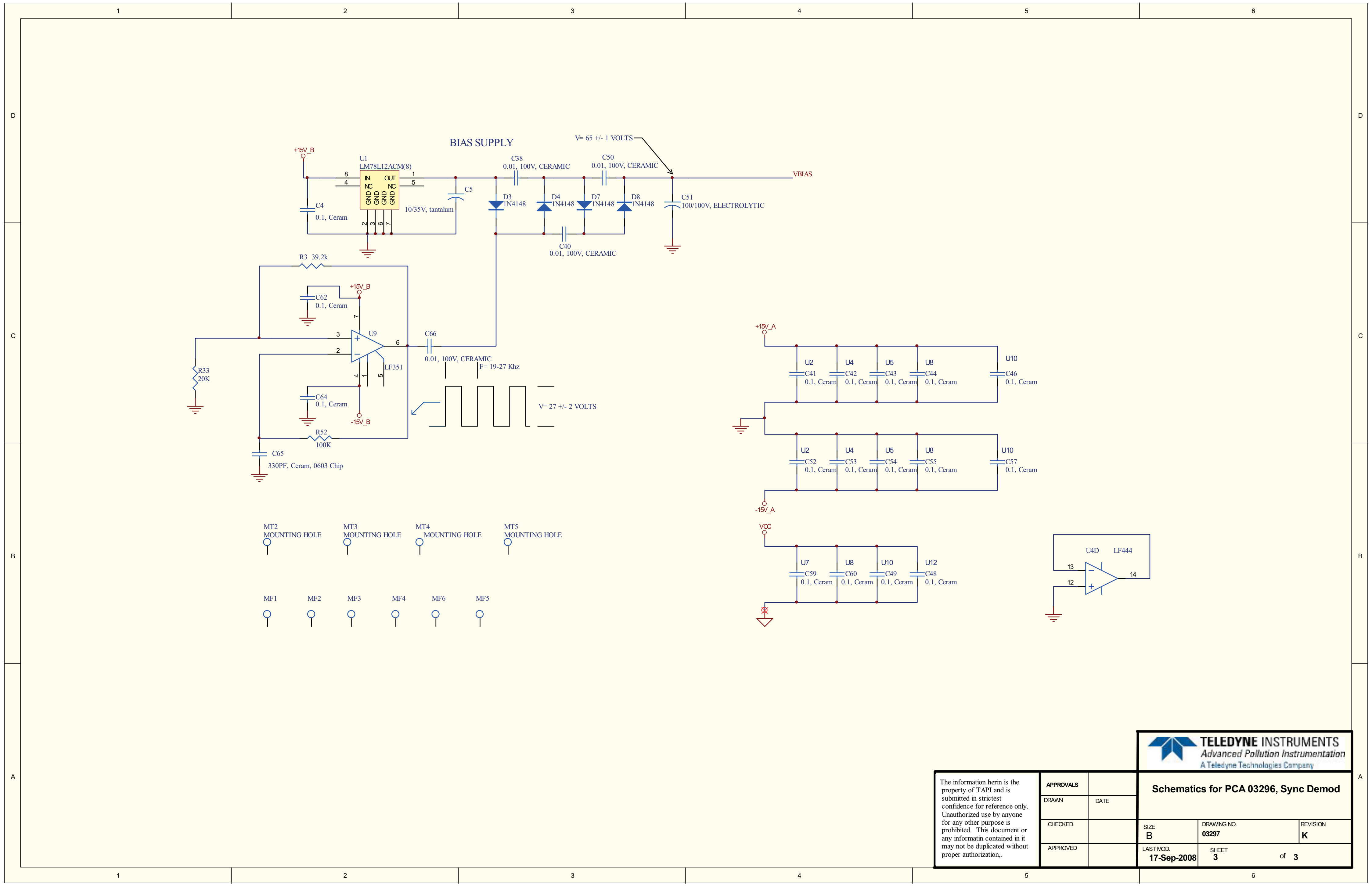
APPROVALS
DRAWN
DATE
CHECKED
APPROVED
Schematics for PCA 03296, Sync Demod
SIZE
B
DRAWING NO.
03297
REVISION
K
LAST MOD.
17-Sep-2008
SHEET
2
of
3



BIAS SUPPLY
V= 65 +/- 1 VOLTS
+15V_B
U1
LM78L12ACM(8)
IN
NC
OUT
NC
GND
C4
0.1, Ceram
C5
10/35V, tantalum
C38
0.01, 100V, CERAMIC
C50
0.01, 100V, CERAMIC
VBIAS
D3
1N4148
D4
1N4148
D7
1N4148
D8
1N4148
C51
100/100V, ELECTROLYTIC
C40
0.01, 100V, CERAMIC
R3 39.2k
C62
0.1, Ceram
U9
LF351
C66
0.01, 100V, CERAMIC
F= 19-27 Khz
V= 27 +/- 2 VOLTS
R33
20K
C64
0.1, Ceram
-15V_B
R52
100K
C65
330PF, Ceram, 0603 Chip
+15V_A
U2
U4
U5
U8
U10
C41
0.1, Ceram
C42
0.1, Ceram
C43
0.1, Ceram
C44
0.1, Ceram
C46
0.1, Ceram
C52
0.1, Ceram
C53
0.1, Ceram
C54
0.1, Ceram
C55
0.1, Ceram
C57
0.1, Ceram
-15V_A
VCC
U7
U12
C59
0.1, Ceram
C60
0.1, Ceram
C49
0.1, Ceram
C48
0.1, Ceram
U4D
LF444
MT2
MOUNTING HOLE
MT3
MOUNTING HOLE
MT4
MOUNTING HOLE
MT5
MOUNTING HOLE
MF1
MF2
MF3
MF4
MF6
MF5
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DATE
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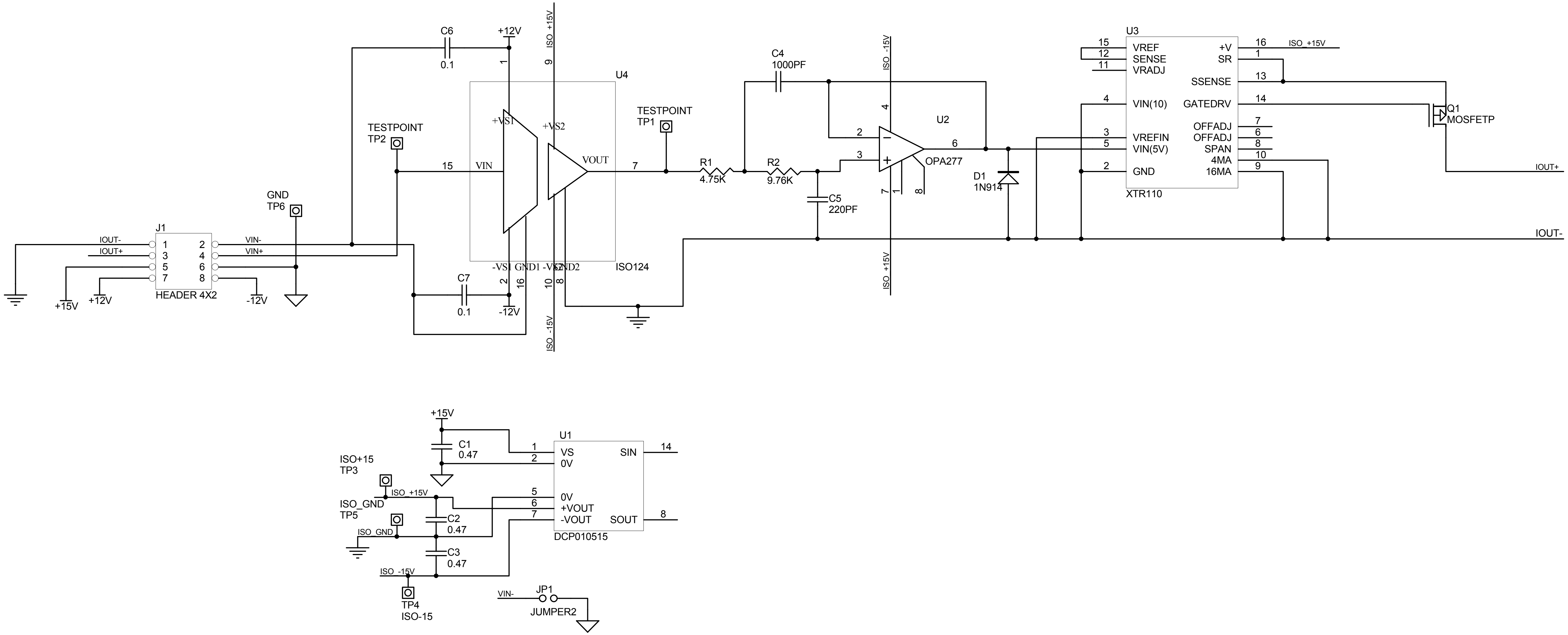
APPROVED
Schematics for PCA 03296, Sync Demod
SIZE
B
DRAWING NO.
03297
REVISION
K
LAST MOD.
17-Sep-2008
SHEET
3
of
3



Date	Rev.	Change Description	Engineer
8/9/00	A	INITIAL RELEASE (FROM 03039)	KL

Error : LOGO.BMP file not found.

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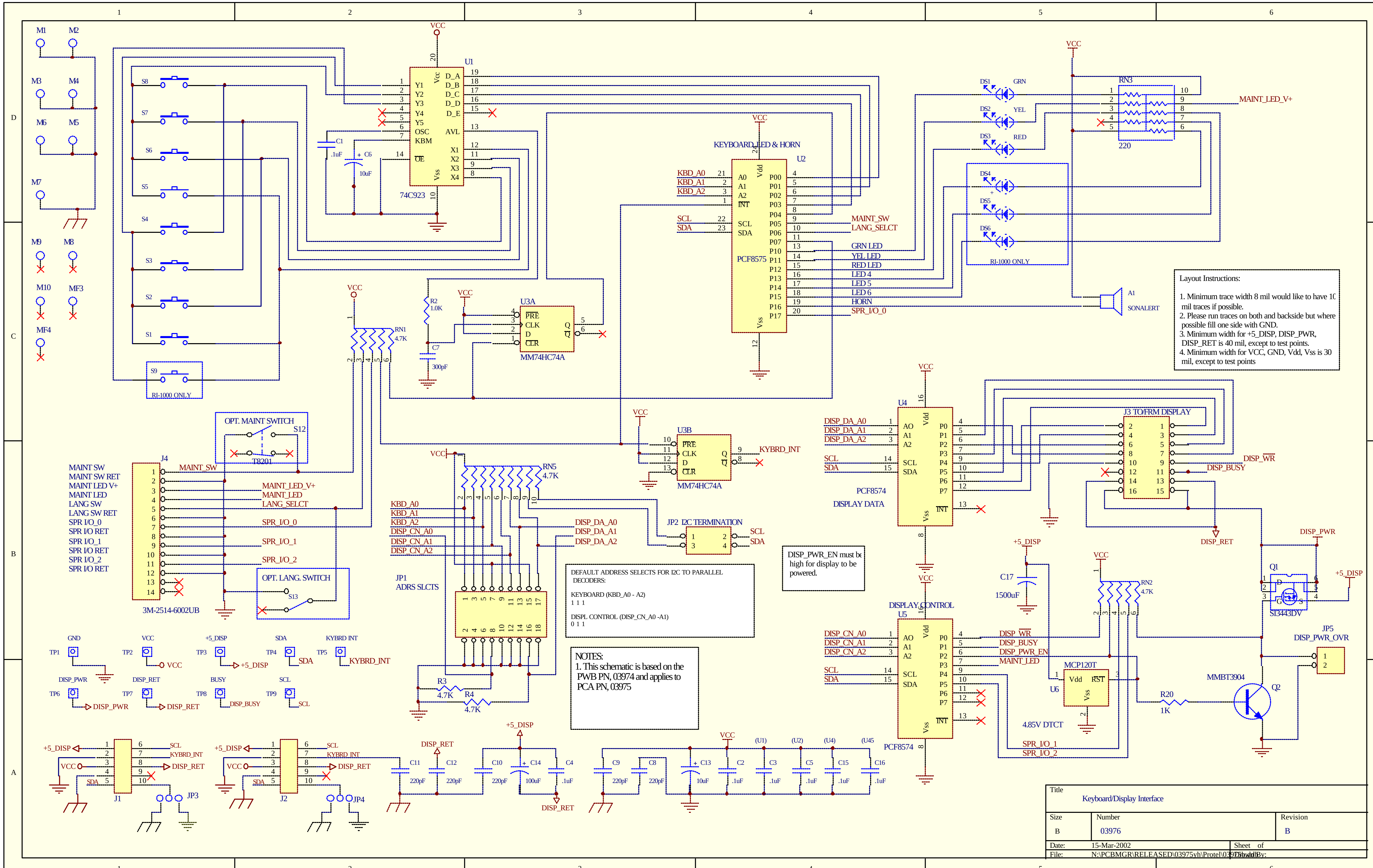
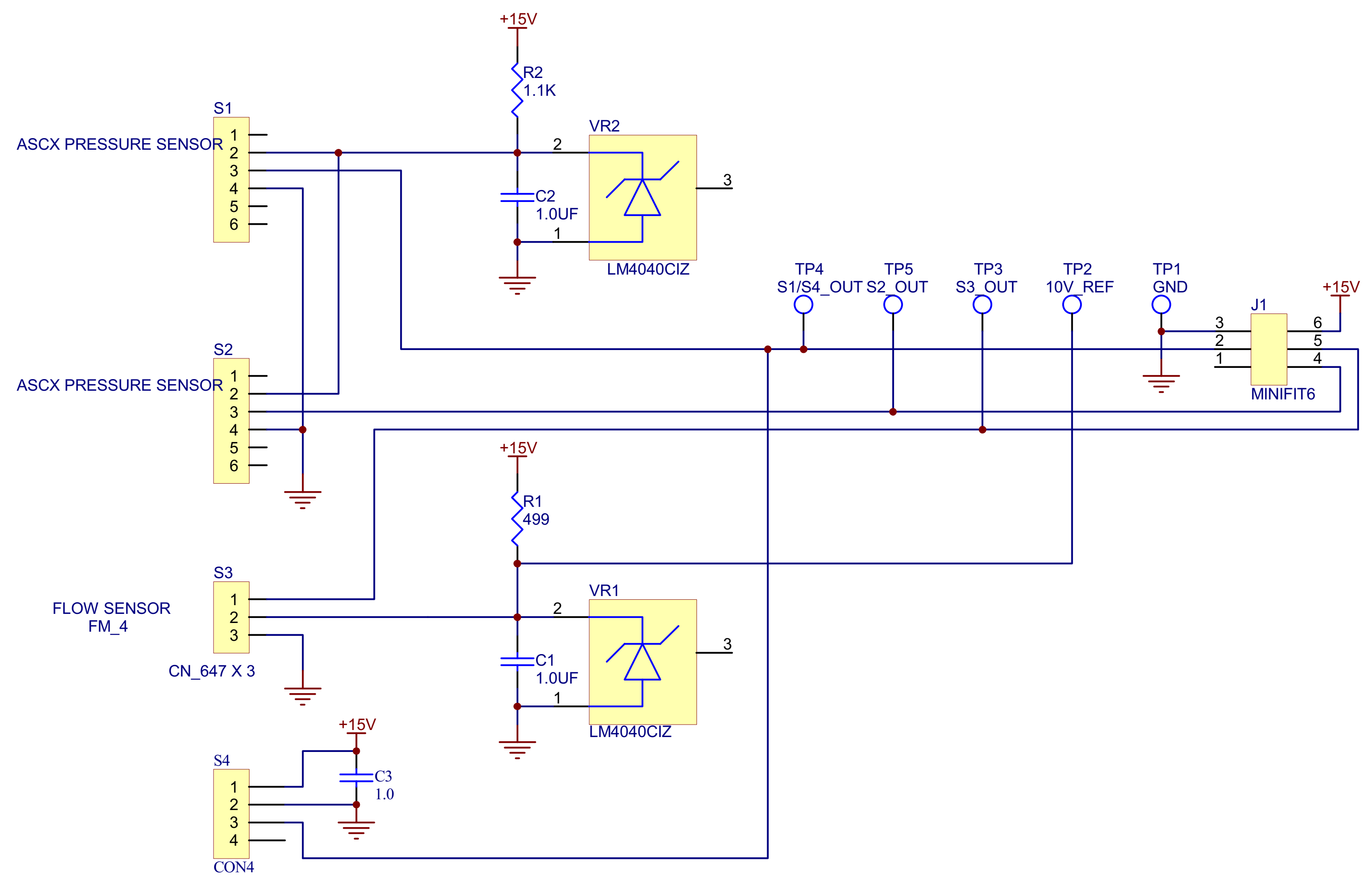
APPROVALS	DATE
DRAWN	
CHECKED	
APPROVED	

PCA 03631, Isolated 0-20ma, E Series

SIZE	DRAWING NO.	REVISION
B	03632	A

LAST MOD. 19-Jul-2002 SHEET 1 of 1


Layout Instructions:
1. Minimum trace width 8 mil would like to have 10 mil traces if possible.
2. Please run traces on both and backside but where possible fill one side with GND.
3. Minimum width for +5_DISP, DISP_PWR, DISP_RET is 40 mil, except to test points.
4. Minimum width for VCC, GND, Vdd, Vss is 30 mil, except to test points
DEFAULT ADDRESS SELECTS FOR I2C TO PARALLEL DECODERS:
KEYBOARD (KBD_A0 - A2)
1 1 1
DISPL CONTROL (DISP_CN_A0 -A1)
0 1 1
NOTES:
1. This schematic is based on the PWB PN, 03974 and applies to PCA PN, 03975
DISP_PWR_EN must be high for display to be powered.
KEYBOARD, LED & HORN
DISPLAY DATA
DISPLAY CONTROL
J3 TO/FRM DISPLAY
OPT. MAINT SWITCH
OPT. LANG. SWITCH
JP2 I2C TERMINATION
JP1 ADRS SLCTS
JP5 DISP_PWR_OVR
RI-1000 ONLY
3M-2514-6002UB
Title
Keyboard/Display Interface
Size
B
Number
03976
Revision
B
Date: 15-Mar-2002
Sheet of
File: N:\PCBMGR\RELEASED\03975vh\Protel\03975.ddb
Drawn By:



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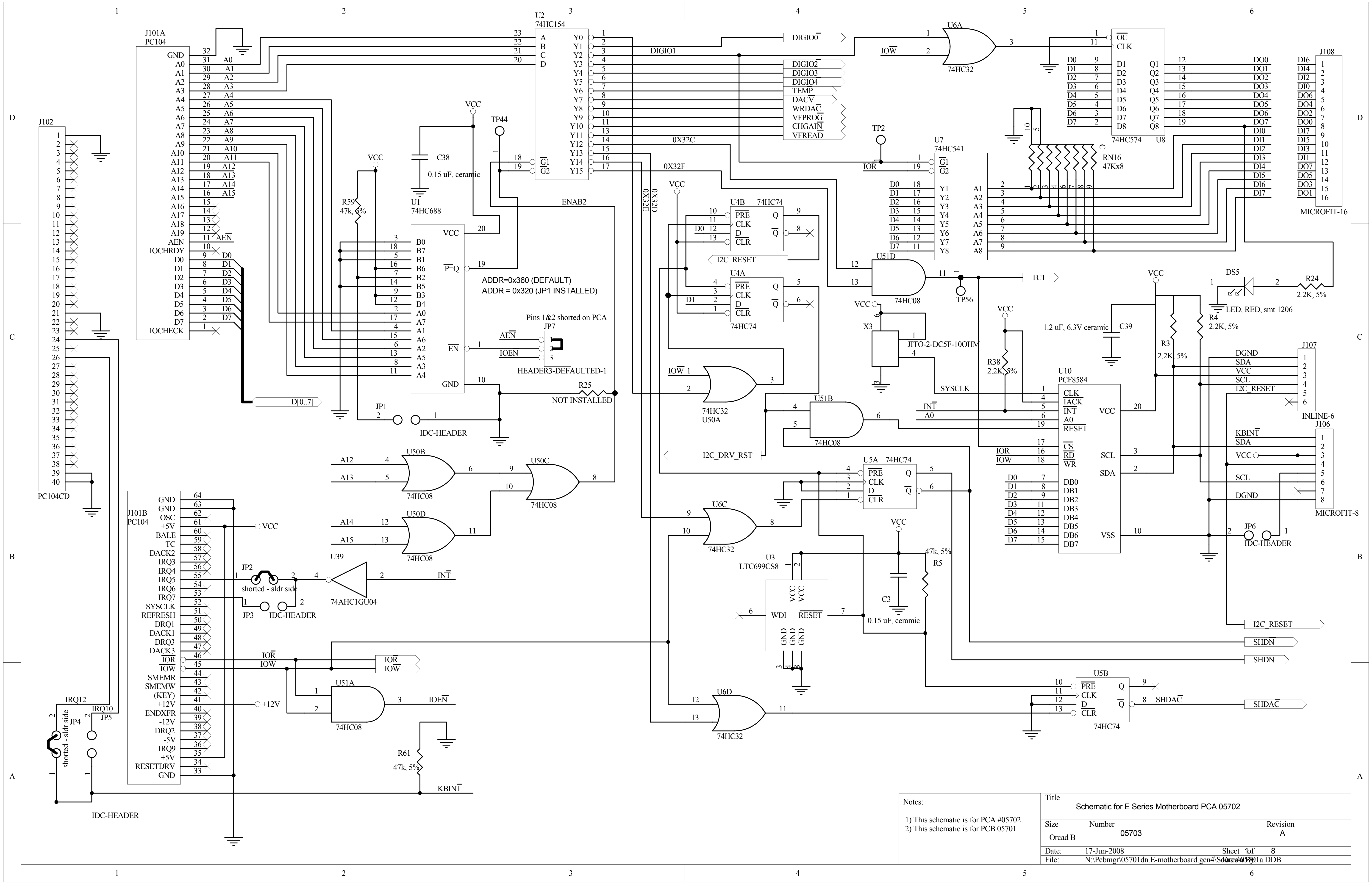
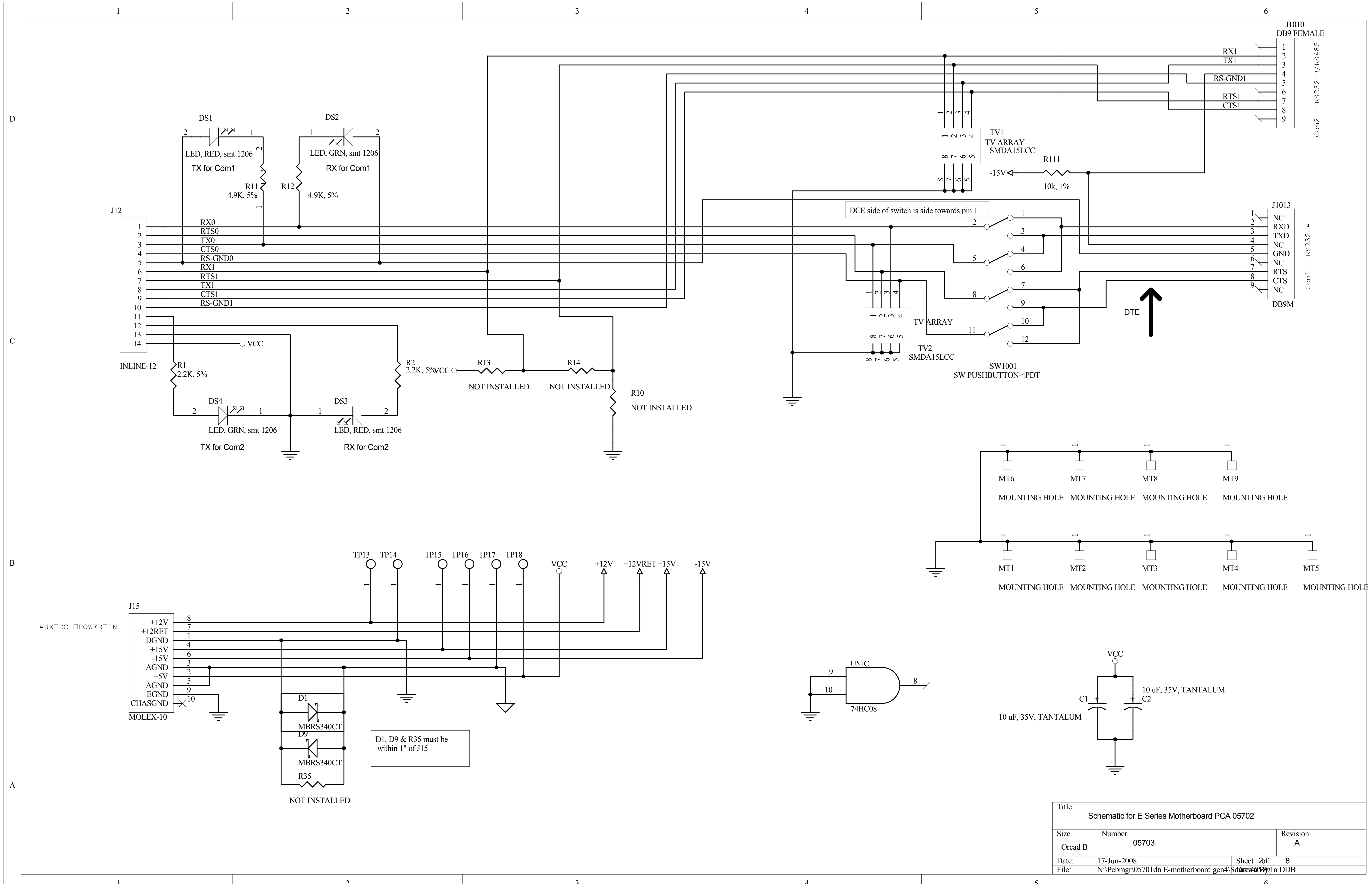
APPROVALS	DATE
DRAWN	
CHECKED	
APPROVED	

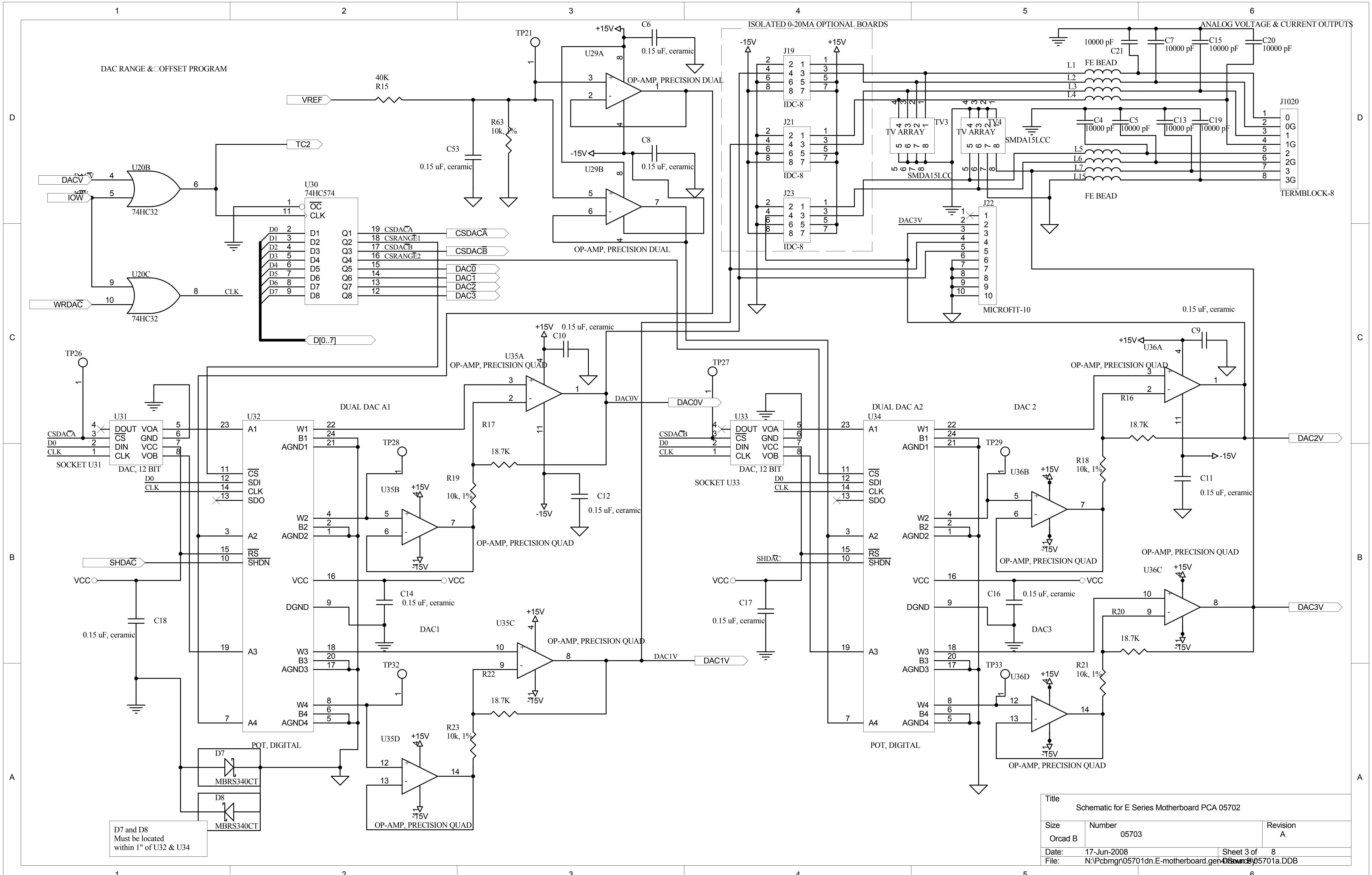
SCH, PCA 04003, PRESS/FLOW, 'E' SERIES

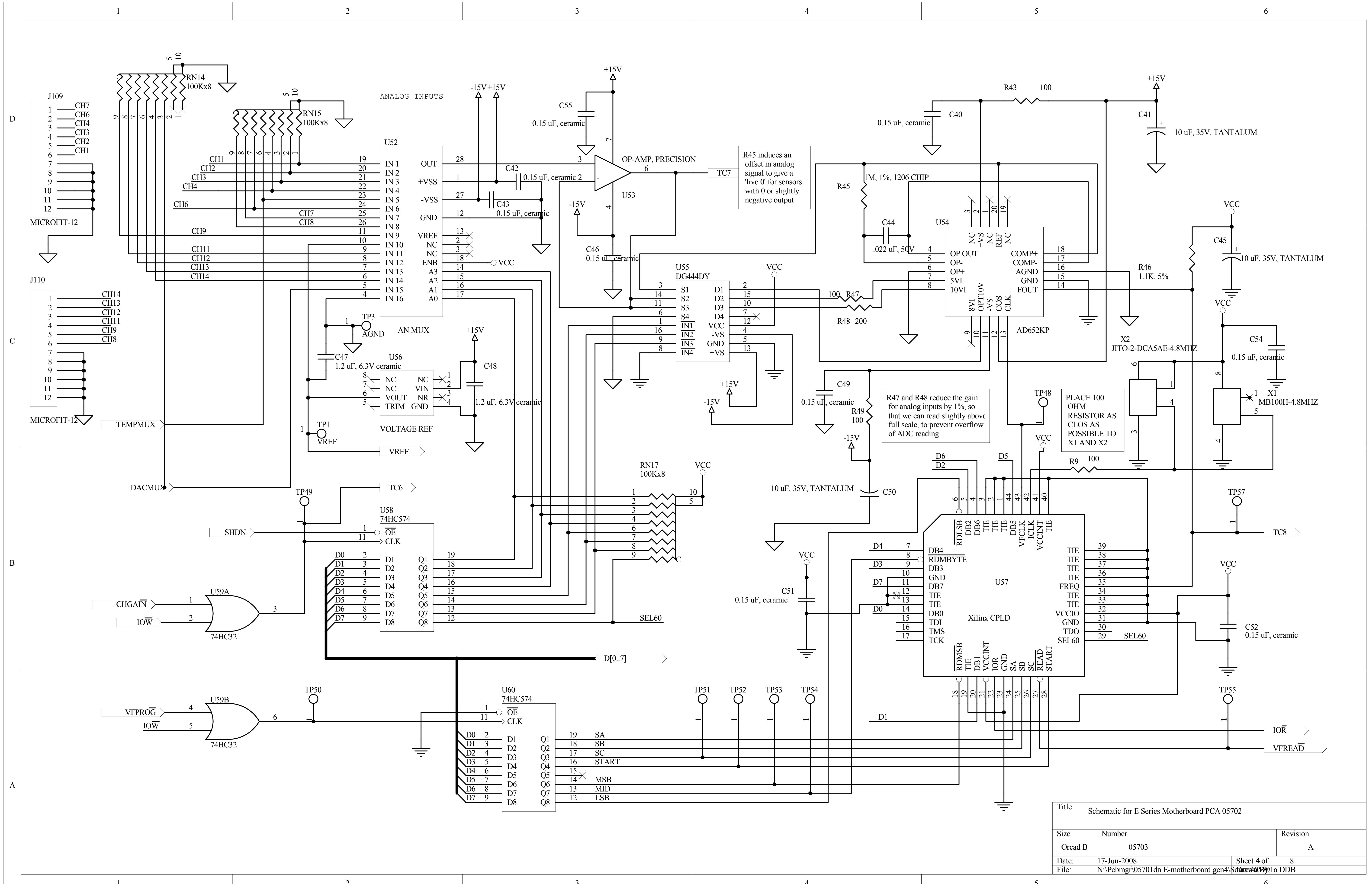
SIZE	DRAWING NO.	REVISION
B	04354	D

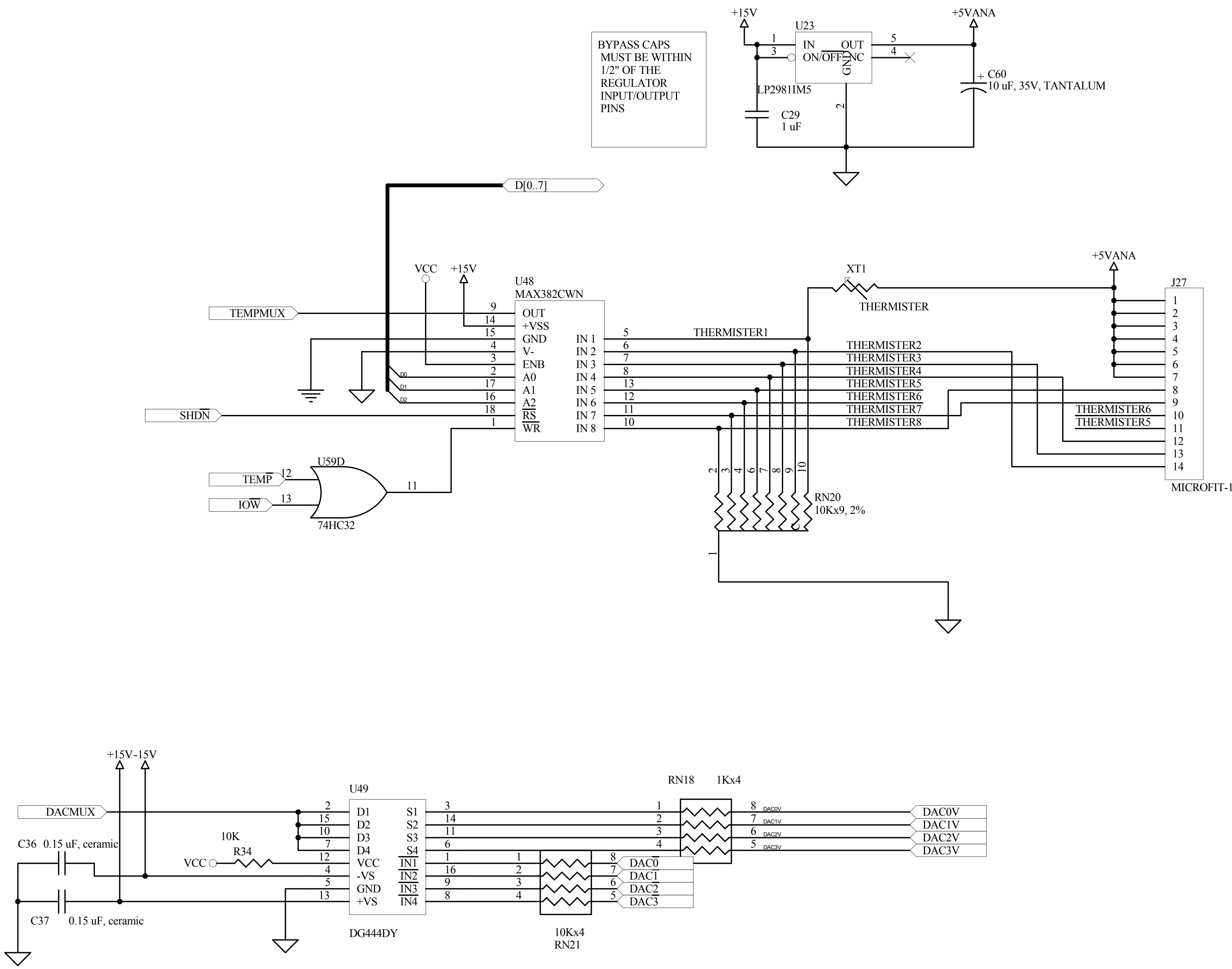
LAST MOD. 3-Dec-2007 SHEET 1 of 1


Schematic for E Series Motherboard PCA 05702
Notes:
1) This schematic is for PCA #05702
2) This schematic is for PCB 05701
Size Orcad B
Number 05703
Revision A
Date: 17-Jun-2008
Sheet 1 of 8
File: N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB
J101A PC104
J101B PC104
J102 PC104CD
U2 74HC154
U1 74HC688
ADDR=0x360 (DEFAULT)
ADDR = 0x320 (JP1 INSTALLED)
Pins 1&2 shorted on PCA
JP7 HEADER3-DEFAULTED-1
C38 0.15 uF, ceramic
R59 47k, 5%
R25 NOT INSTALLED
JP1 IDC-HEADER
U6A 74HC32
U8 74HC574
U7 74HC541
RN16 47Kx8
J108 MICROFIT-16
U4B 74HC74
U4A 74HC74
I2C_RESET
U51D 74HC08
TP56
TC1
X3 JITO-2-DC5F-10OHM
R38 2.2K, 5%
U10 PCF8584
C39 1.2 uF, 6.3V ceramic
DS5 LED, RED, smt 1206
R24 2.2K, 5%
R3 2.2K, 5%
R4 2.2K, 5%
J107 INLINE-6
J106 MICROFIT-8
JP6 IDC-HEADER
U50A 74HC32
U51B 74HC08
I2C_DRV_RST
U5A 74HC74
U50B 74HC08
U50C 74HC08
U50D 74HC08
U6C 74HC32
U3 LTC699CS8
C3 0.15 uF, ceramic
R5 47k, 5%
U39 74AHC1GU04
JP2 shorted - sldr side
JP3 IDC-HEADER
U51A 74HC08
R61 47k, 5%
U6D 74HC32
U5B 74HC74
SHDN
SHDAC
JP4 shorted - sldr side
JP5
IDC-HEADER
KBINT
D[0..7]

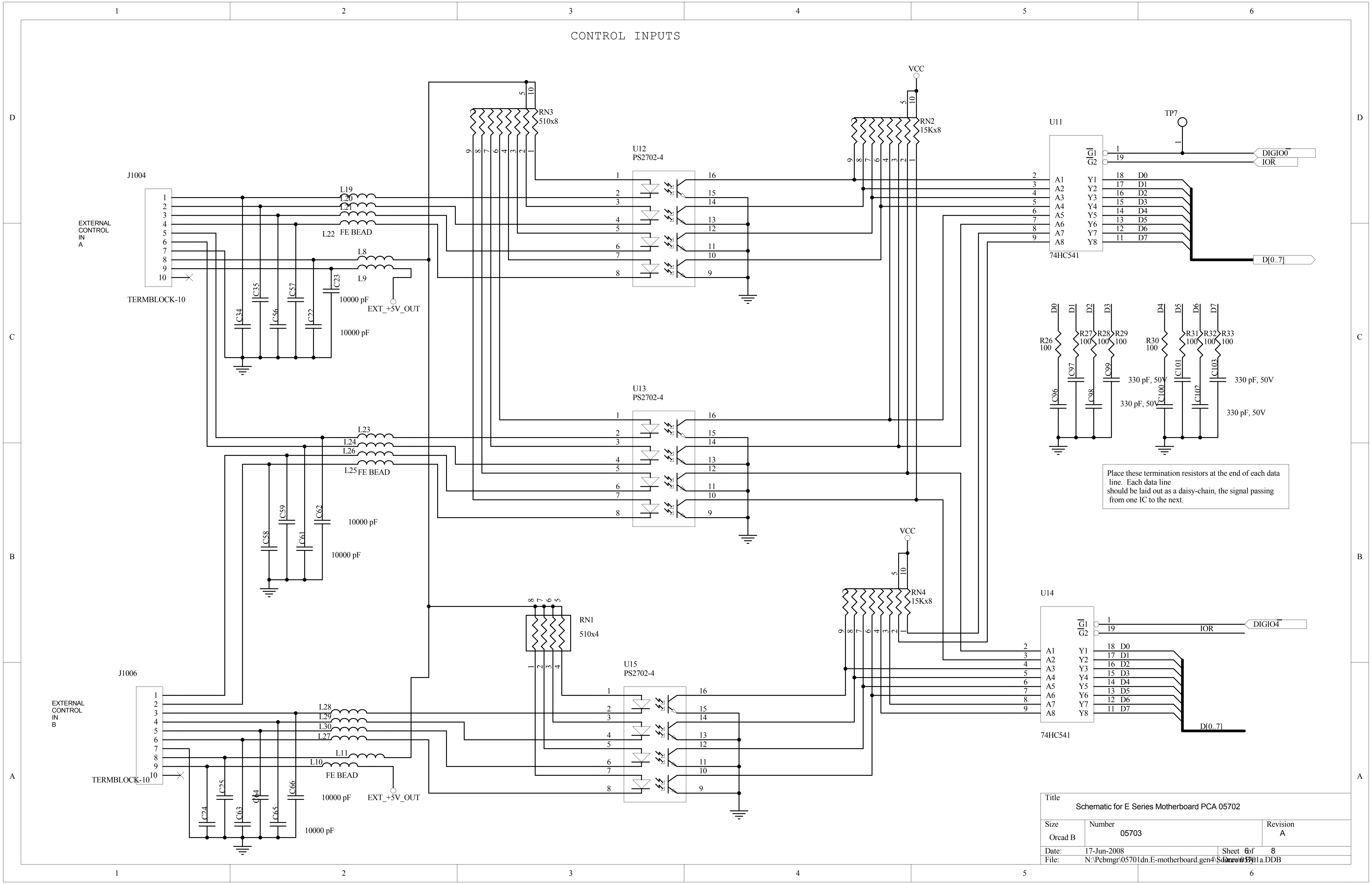

J1010
DB9 FEMALE
Com2 - RS232-B/RS485
RX1
TX1
RS-GND1
RTS1
CTS1
TV1
TV ARRAY
SMDA15LCC
R111
10k, 1%
-15V
DS1
LED, RED, smt 1206
TX for Com1
R11
4.9K, 5%
DS2
LED, GRN, smt 1206
RX for Com1
R12
4.9K, 5%
J12
RX0
RTS0
TX0
CTS0
RS-GND0
RX1
RTS1
TX1
CTS1
RS-GND1
VCC
INLINE-12
R1
2.2K, 5%
R2
2.2K, 5%
DS4
LED, GRN, smt 1206
TX for Com2
DS3
LED, RED, smt 1206
RX for Com2
R13
NOT INSTALLED
R14
NOT INSTALLED
R10
NOT INSTALLED
DCE side of switch is side towards pin 1.
TV ARRAY
TV2
SMDA15LCC
SW1001
SW PUSHBUTTON-4PDT
J1013
NC
RXD
TXD
NC
GND
NC
RTS
CTS
NC
DB9M
Com1 - RS232-A
DTE
MT6
MT7
MT8
MT9
MT1
MT2
MT3
MT4
MT5
MOUNTING HOLE
TP13
TP14
TP15
TP16
TP17
TP18
+12V
+12VRET
+15V
-15V
J15
AUX DC POWER IN
+12V
+12RET
DGND
+15V
-15V
AGND
+5V
AGND
EGND
CHASGND
MOLEX-10
D1
MBRS340CT
D9
MBRS340CT
R35
NOT INSTALLED
D1, D9 & R35 must be within 1" of J15
U51C
74HC08
C1
C2
10 uF, 35V, TANTALUM
10 uF, 35V, TANTALUM
Title
Schematic for E Series Motherboard PCA 05702
Size
Orcad B
Number
05703
Revision
A
Date: 17-Jun-2008
Sheet 2 of 8
File: N:\Pebmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB

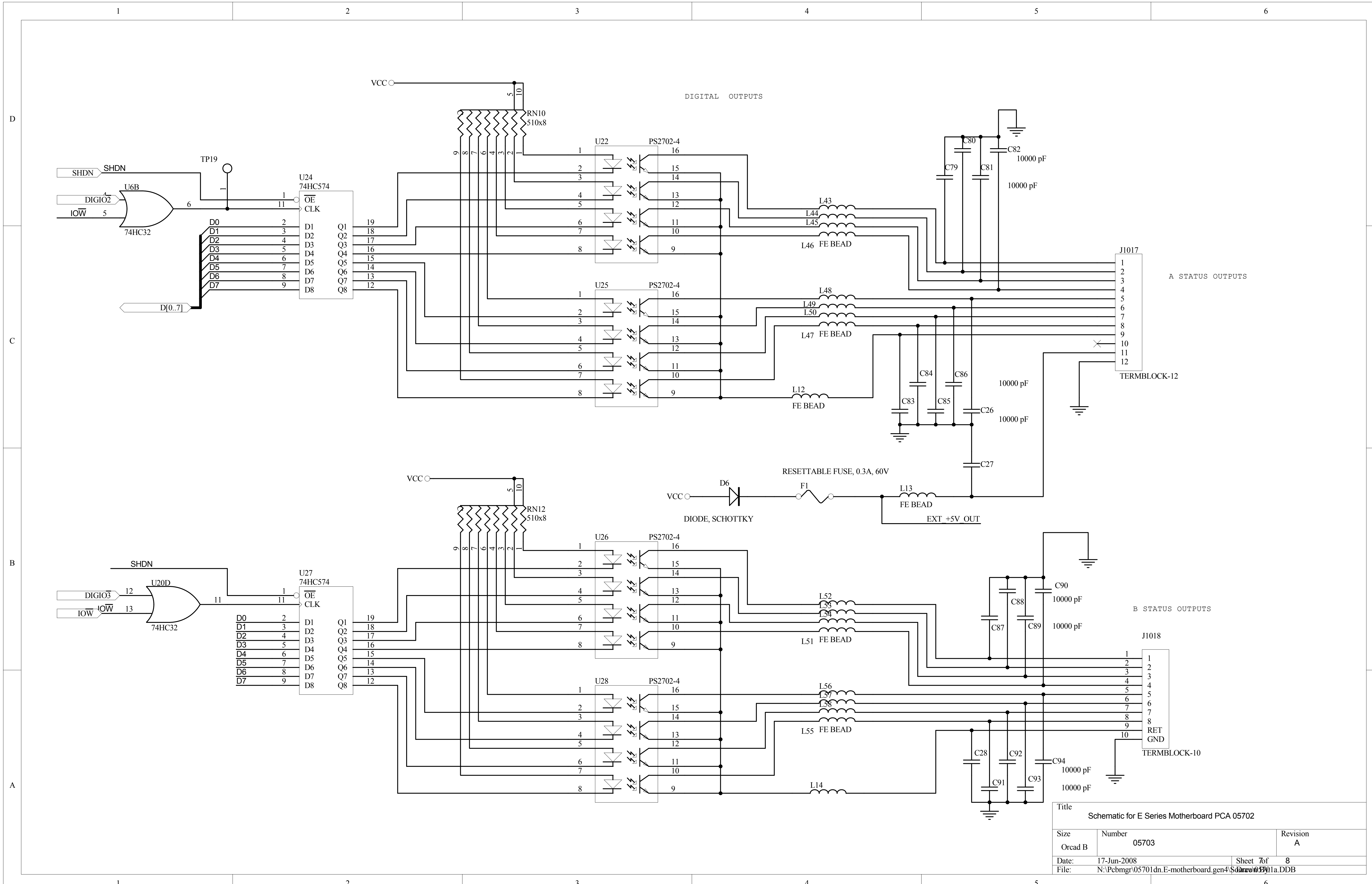

DAC RANGE & OFFSET PROGRAM
ISOLATED 0-20MA OPTIONAL BOARDS
ANALOG VOLTAGE & CURRENT OUTPUTS
VREF
TC2
DACV
IOW
WRDAC
SHDAC
U20B
U20C
74HC32
U30
74HC574
CSDACA
CSDACB
CSRANGE1
CSRANGE2
DAC0
DAC1
DAC2
DAC3
D[0..7]
CLK
40K
R15
R63
10k, 1%
C53
0.15 uF, ceramic
TP21
U29A
U29B
OP-AMP, PRECISION DUAL
C6
C8
+15V
-15V
J19
J21
J23
IDC-8
TV ARRAY
TV3
TV4
SMDA15LCC
FE BEAD
L1
L2
L3
L4
L5
L6
L7
L15
C21
C7
C15
C20
C4
C5
C13
C19
10000 pF
J1020
TERMBLOCK-8
J22
MICROFIT-10
DAC3V
TP26
U31
SOCKET U31
DAC, 12 BIT
U32
DUAL DAC A1
POT, DIGITAL
U35A
U35B
U35C
U35D
OP-AMP, PRECISION QUAD
R17
R19
R22
R23
18.7K
C10
C12
C14
C18
DAC0V
DAC1V
TP27
TP28
TP32
D7
D8
MBRS340CT
D7 and D8
Must be located
within 1" of U32 & U34
U33
SOCKET U33
U34
DUAL DAC A2
DAC 2
U36A
U36B
U36C
U36D
R16
R18
R20
R21
C9
C11
C16
C17
TP29
TP33
DAC2V
DAC3V
VCC
Title
Schematic for E Series Motherboard PCA 05702
Size
Orcad B
Number
05703
Revision
A
Date:
17-Jun-2008
Sheet 3 of 8
File:
N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB
Drawn By:


ANALOG INPUTS
J109
MICROFIT-12
J110
MICROFIT-12
RN14
100Kx8
RN15
100Kx8
U52
AN MUX
U53
OP-AMP, PRECISION
R45 induces an offset in analog signal to give a 'live 0' for sensors with 0 or slightly negative output
U54
AD652KP
U55
DG444DY
U56
VOLTAGE REF
U58
74HC574
U59A
74HC32
U59B
74HC32
U60
74HC574
U57
Xilinx CPLD
R47 and R48 reduce the gain for analog inputs by 1%, so that we can read slightly above full scale, to prevent overflow of ADC reading
PLACE 100 OHM RESISTOR AS CLOS AS POSSIBLE TO X1 AND X2
X1
MB100H-4.8MHZ
X2
JITO-2-DCA5AE-4.8MHZ
RN17
100Kx8
TEMPMUX
DACMUX
SHDN
CHGAIN
IOW
VFPROG
VREF
TC6
TC7
TC8
SEL60
D[0..7]
IOR
VFREAD
Title
Schematic for E Series Motherboard PCA 05702
Size
Orcad B
Number
05703
Revision
A
Date: 17-Jun-2008
Sheet 4 of 8
File: N:\Pebmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB

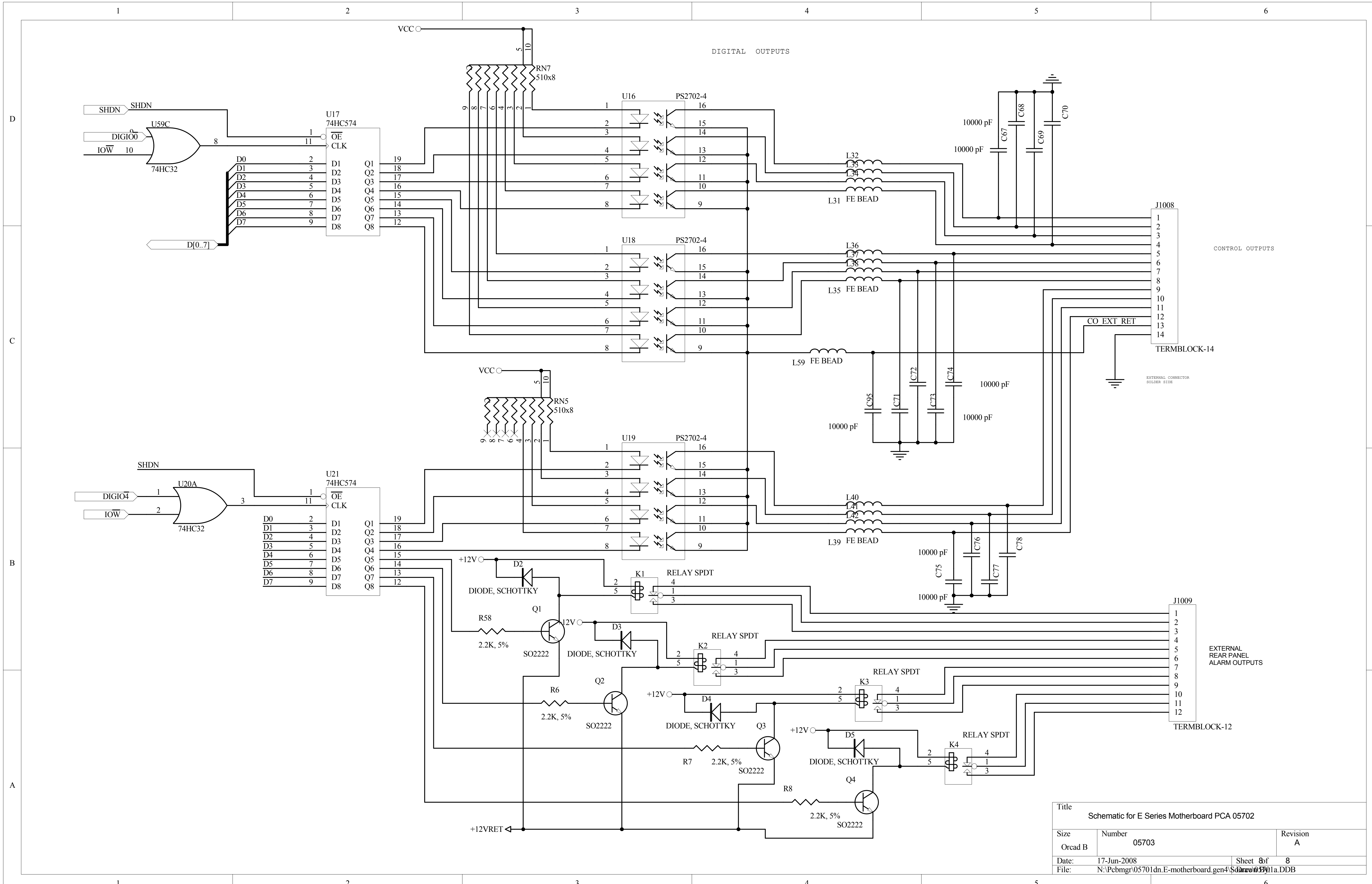


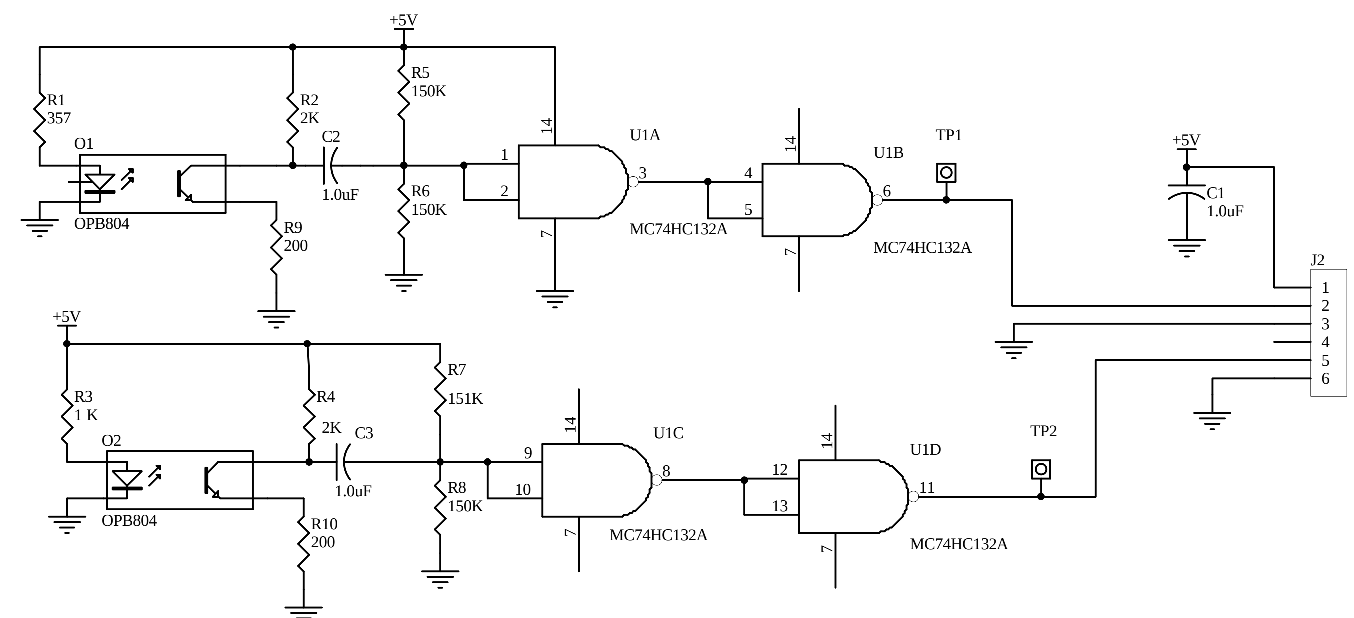
Title: Schematic for E Series Motherboard PCA 05702		
Size: Orcad B	Number: 05703	Revision: A
Date: 17-Jun-2008	Sheet 5 of 8	
File: N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB	Drawn By:	


CONTROL INPUTS
J1004
EXTERNAL CONTROL IN A
TERMBLOCK-10
J1006
EXTERNAL CONTROL IN B
TERMBLOCK-10
RN3 510x8
RN2 15Kx8
RN4 15Kx8
RN1 510x4
U12 PS2702-4
U13 PS2702-4
U15 PS2702-4
U11 74HC541
U14 74HC541
FE BEAD
EXT_+5V_OUT
10000 pF
330 pF, 50V
VCC
TP7
DIGIO0
DIGIO4
IOR
D[0..7]
Place these termination resistors at the end of each data line. Each data line should be laid out as a daisy-chain, the signal passing from one IC to the next.
Title
Schematic for E Series Motherboard PCA 05702
Size Orcad B
Number 05703
Revision A
Date: 17-Jun-2008
Sheet 6 of 8
File: N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB



Title	Schematic for E Series Motherboard PCA 05702		
Size: Orcad B	Number: 05703		Revision: A
Date: 17-Jun-2008		Sheet 7 of 8	
File: N:\Pcbmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB			


DIGITAL OUTPUTS
CONTROL OUTPUTS
EXTERNAL
REAR PANEL
ALARM OUTPUTS
U17 74HC574
U21 74HC574
U16 PS2702-4
U18 PS2702-4
U19 PS2702-4
RN7 510x8
RN5 510x8
U59C 74HC32
U20A 74HC32
J1008 TERMBLOCK-14
J1009 TERMBLOCK-12
CO EXT RET
FE BEAD
10000 pF
RELAY SPDT
DIODE, SCHOTTKY
2.2K, 5%
SO2222
+12VRET
Title
Schematic for E Series Motherboard PCA 05702
Size
Orcad B
Number
05703
Revision
A
Date: 17-Jun-2008
File: N:\Pebmgr\05701dn.E-motherboard.gen4\Source\05701a.DDB



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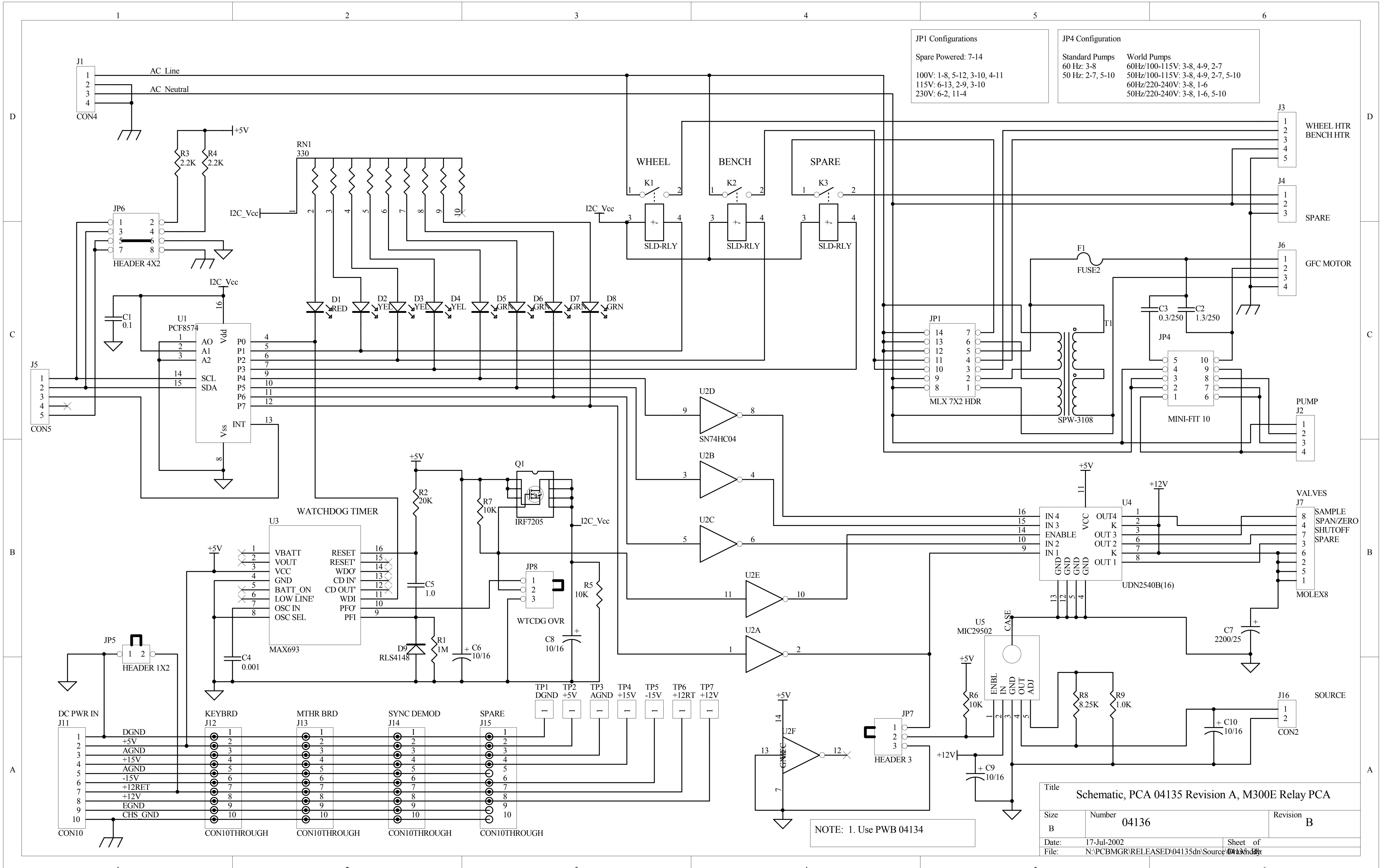
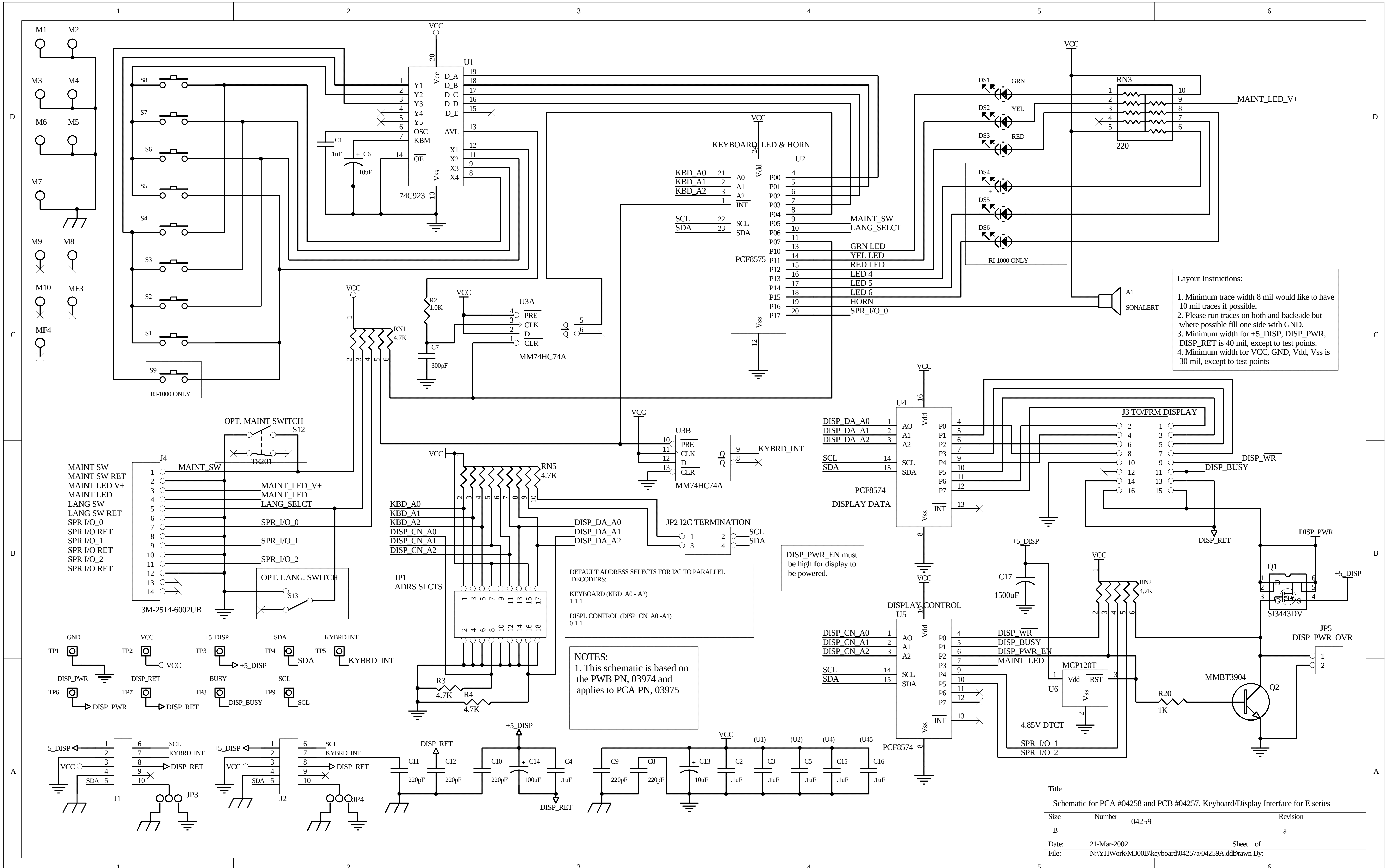
APPROVALS		
DRAWN CAC	DATE 4/30/01	
CHECKED		
APPROVED		

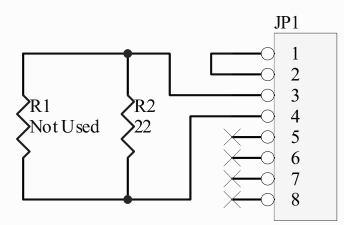
Schematics for PWB 04087 and PCA 04088 OPTO-INTERRUPTER

SIZE	DRAWING NO.	REVISION
B	04089	A

LAST MOD.	SHEET
2-Apr-2002	1 of 1


JP1 Configurations
Spare Powered: 7-14
100V: 1-8, 5-12, 3-10, 4-11
115V: 6-13, 2-9, 3-10
230V: 6-2, 11-4
JP4 Configuration
Standard Pumps
60 Hz: 3-8
50 Hz: 2-7, 5-10
World Pumps
60Hz/100-115V: 3-8, 4-9, 2-7
50Hz/100-115V: 3-8, 4-9, 2-7, 5-10
60Hz/220-240V: 3-8, 1-6
50Hz/220-240V: 3-8, 1-6, 5-10
AC_Line
AC_Neutral
WHEEL
BENCH
SPARE
WHEEL HTR
BENCH HTR
GFC MOTOR
PUMP
WATCHDOG TIMER
WTCDG OVR
VALVES
SAMPLE
SPAN/ZERO
SHUTOFF
SPARE
SOURCE
DC PWR IN
KEYBRD
MTHR BRD
SYNC DEMOD
SPARE
NOTE: 1. Use PWB 04134
Title
Schematic, PCA 04135 Revision A, M300E Relay PCA
Size B
Number 04136
Revision B
Date: 17-Jul-2002
File: N:\PCBMGR\RELEASED\04135dn\Source\04135.ddb


U1
74C923
VCC
U2
PCF8575
KEYBOARD, LED & HORN
KBD_A0
KBD_A1
KBD_A2
SCL
SDA
MAINT_SW
LANG_SELCT
GRN LED
YEL LED
RED LED
LED 4
LED 5
LED 6
HORN
SPR_I/O_0
RN3
220
MAINT_LED_V+
DS1
GRN
DS2
YEL
DS3
RED
DS4
DS5
DS6
RI-1000 ONLY
A1
SONALERT
Layout Instructions:
1. Minimum trace width 8 mil would like to have 10 mil traces if possible.
2. Please run traces on both and backside but where possible fill one side with GND.
3. Minimum width for +5_DISP, DISP_PWR, DISP_RET is 40 mil, except to test points.
4. Minimum width for VCC, GND, Vdd, Vss is 30 mil, except to test points
U3A
MM74HC74A
R2
1.0K
C7
300pF
RN1
4.7K
S1
S2
S3
S4
S5
S6
S7
S8
S9
RI-1000 ONLY
M1
M2
M3
M4
M5
M6
M7
M8
M9
M10
MF3
MF4
OPT. MAINT SWITCH
S12
T8201
J4
3M-2514-6002UB
MAINT SW
MAINT SW RET
MAINT LED V+
MAINT LED
LANG SW
LANG SW RET
SPR I/O_0
SPR I/O RET
SPR I/O_1
SPR I/O RET
SPR I/O_2
SPR I/O RET
MAINT_LED_V+
MAINT_LED
LANG_SELCT
SPR_I/O_0
SPR_I/O_1
SPR_I/O_2
OPT. LANG. SWITCH
S13
RN5
4.7K
KBD_A0
KBD_A1
KBD_A2
DISP_CN_A0
DISP_CN_A1
DISP_CN_A2
DISP_DA_A0
DISP_DA_A1
DISP_DA_A2
JP1
ADRS SLCTS
U3B
MM74HC74A
KYBRD_INT
JP2 I2C TERMINATION
DEFAULT ADDRESS SELECTS FOR I2C TO PARALLEL DECODERS:
KEYBOARD (KBD_A0 - A2)
1 1 1
DISPL CONTROL (DISP_CN_A0 -A1)
0 1 1
NOTES:
1. This schematic is based on the PWB PN, 03974 and applies to PCA PN, 03975
U4
PCF8574
DISPLAY DATA
J3 TO/FRM DISPLAY
DISP_WR
DISP_BUSY
DISP_RET
DISP_PWR_EN must be high for display to be powered.
C17
1500uF
+5_DISP
RN2
4.7K
Q1
SI3443DV
DISP_PWR
JP5
DISP_PWR_OVR
DISPLAY_CONTROL
U5
PCF8574
DISP_WR
DISP_BUSY
DISP_PWR_EN
MAINT_LED
MCP120T
U6
4.85V DTCT
R20
1K
MMBT3904
Q2
SPR_I/O_1
SPR_I/O_2
GND
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
TP9
BUSY
R3
4.7K
R4
4.7K
J1
J2
JP3
JP4
C11
C12
C10
C14
C4
C9
C8
C13
C2
C3
C5
C15
C16
220pF
100uF
10uF
.1uF
Title
Schematic for PCA #04258 and PCB #04257, Keyboard/Display Interface for E series
Size
B
Number
04259
Revision
a
Date:
21-Mar-2002
Sheet of
File:
N:\YHWork\M300B\keyboard\04257a\04259A.ddb
Drawn By:



Title: SCH, E-Series Analog Output Isolator, PCA 04467		
Size: A	Number: 04468	Revision: B
Date: 6/28/2004		Sheet of
File: N:\PCBMGR\..\04468B.sch		Drawn By: